Efficacy of Defoliants on Yield and Fibre Quality of American Cotton in Semi-Arid Conditions

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ABSTRACT

The study was conducted for exploring the effect of Dropp ultra and Ethrel, their application rates and time of application on two American cotton cultivars. The experiment was carried out at Regional Agricultural Research Station, Nandyal with cultivars NH615 and Sivanandi for two consecutive seasons from 2015-2017 in split plot design with three replications. Application of defoliants like Dropp ultra SC (Thidiazuron 360 + Diuron 180) 200 and 250 ml/ha, Ethrel 1500, 2000 and 3000 ppm were carried at 120 and 140 days after sowing respectively. The results of the study indicated that defoliation with Dropp ultra 250 ml/ha recorded higher percentage of defoliation (92.3) and higher seed cotton yield (2207 kg/ha). Application of defoliants at 140 days after sowing significantly recorded higher yields. There was no difference between the treatments in terms of fibre length and fibre strength. However fibre fineness and uniformity ratio were significantly affected by application of defoliants.

Key words: Dropp ultra, Defoliation, Ethrel, Seed cotton Yield.

INTRODUCTION

Cotton is the most important crop contributing nearly 75% of total raw material needs of textile industry in India and was recognized as the cradle of cotton industry for over 3000 years (155 BC to 1700 AD). India being the earliest country in the world for domesticated cotton production and manufacture of cotton fabrics, and is cultivated in area of 122.38 lakh ha with a production of 361 bales per ha and productivity of 501 kg lint/ha. Among the states Maharashtra, Gujarat and Telangana were the major cotton growing states covering around 70.45% (86.22 lakh hectare) in area under cotton cultivation and 62.60% (226 lakh bales) of cotton production in India (AICCIP- Annual Report, 2018-19).

Cotton picking through harvest aids like defoliants helps to drop leaves, open bolls and desiccate plants further without any affect on fibre quality. Maintaining fiber quantity and quality is one of the great challenges while using harvest aids for defoliation and synchronous boll opening. Advantages associated with defoliant application prior to cotton harvest include, reduction in leaf trash content in harvested lint, quicker drying of dew and early boll opening due to full exposure to sunlight (Awan et al., 2012).

Cotton defoliation is a sensitive process. For a successful harvest, defoliation must be carefully timed and carried out. Poor defoliation can lower fibre quality, while defoliating too early lowers yield and micronaire. Defoliating too late increases the likelihood of boll rot and lint damage or loss due to weath-ering. Late defoliating also increases the possibility that defoliant activity will be inhibited by lower temperatures. Cotton defoliation is often practiced when 60% of bolls are opened to avoid loss in yield and fibre quality (Snipes and Baskin, 1994). Many researchers use the rule that it is safe to defoliate cotton when about 60 percent of the bolls are open. Although this strategy may work well in most situations, defoliation errors may occur where the crop is set more quickly or more slowly than normal. The defoliation process usually completes in 7 to 10 days, but in some situations, it may be delayed for as long as 30 days (Cathey, 1986; Gwathmey and Hayes, 1997; Malik and Din, 1997). The success of defoliation process depends on the maturity of cotton crop and prevailing weather conditions at the time of application (Mrunalini et al. 2018). Cotton growers are inclined to improve profit margins by adopting improved cotton production practices while maintaining yield (Singh et al. 2019). The objectives of this research were to standardize the time of application and dosage of defoliant which may realize an early crop with more seed cotton yield and best fibre quality.

MATERIALS AND METHODS

The experiment was conducted during Kharif for two consecutive seasons from 2015-2017 at Acharya N G Agricultural University, Regional Agricultural Research Station, Nandyal (15°27’N and 78°28’E) of Andhra Pradesh. The soil of the experimental field is black cotton soil, with pH 8.3 and EC 0.26 dS/m. The experiment was laid out in Split-Split plot design, replicated three times with two cultivars NH615 and Sivanandi as main treatments and defoliants combinations as sub treatments and time of application 120 and 140 days after sowing as sub sub plots.
adopted was 45cm x 10 cm. Treatmental application of defoliants like Dropp ultra SC (Thidiazuron 360 + Diuron 180) 200 ml/ha and 250 ml/ha, Ethrel 1500ppm, 2000ppm and 3000 ppm were carried at 120 and 140 days after sowing respectively. Defoliants were applied using a high clearance research sprayer. Percent defoliation was measured 7 days after spray at harvest using a visual rating system with zero equal to no defoliation and 100 equal to complete defoliation. Mean comparison of studied traits are percent defoliation, bolls/Plant, earliness index, harvest index, fibre length, fibre fineness, fibre strength, uniformity ratio (%) and seed cotton yield. A procedure of earliness index is measured as following

\[
\text{Earliness Index} = \frac{P_1 \times \text{Number of days to last picking}}{P_2 \times \text{Number of days to first picking}} + \frac{P_n}{P_1, P_2, \ldots, P_n}
\]

Where \(P_1, P_2, \ldots, P_n\) being the weight of seed cotton picked during first and second and \(n\) is the total number of pickings.

The data were analyzed using STAR (Statistical tool for agricultural research, IRRI) to test the significance and pooled means have been used to discuss the results.

**RESULTS AND DISCUSSION**

Defoliation in cotton by using different defoliants was influenced by various factors like type of chemical, rate of application, crop coverage, maturity of the plant and weather conditions. Defoliation in cotton depends not only on environmental factors, but also varies with genetic factors (Stewart et al. 2000) and cultivation techniques (Whitwell et al. 1987). The crop completed its defoliation in 15 days after treatment imposition indicating that the temperature prevailing at the time of defoliant application played a significant role in inducing defoliation.

The pooled results revealed that higher seed cotton yield was observed in cultivar NH 615 compared to Sivanandi. The highest seed cotton yield was recorded (1855 Kg/ha) in NH 615 and (1736 kg/ha) in Sivanandi. Similarly higher boll number per plant (30) and open bollcount (25) was significantly higher than Sivanandi. Earliness index (percent first-pick) is most frequently used to estimate earliness in cotton (Bourland et al., 2001). In the present study, earliness index (EI) was significantly affected in all treatments and high harvest index was recorded in NH 615 (37.90) Table 1.

**Effect of defoliants**

The effect of defoliants on the number of bolls per plant, boll bursted after spray are given in Table 1. Among the treatments tested, defoliation with Dropp ultra @ 250 ml/ha resulted in higher number of bolls bursted compared to spraying with other defoliant treatments. At 7 days after defoliant application, there was a significant increase in percent defoliation (92.3%) in Dropp ultra @250ml/ha and (90.0%) in Dropp ultra @ 200ml/ha at and was at par with Ethrel @3000ppm (89.0). Mrunalini et al. (2019) reported that higher leaf defoliation was observed with Dropp ultra @ 200ml/ha and also resulted in reduction of crop duration by 20 days. Earliness index was significantly higher with the application of Dropp ultra @ 250 ml /ha (92.65) followed by Ethrel @3000ppm (89.07) and significantly superior to other treatments. Singh et al. (2014) found reduced seed cotton yield and severe shedding of young squares and young bolls by application of Dropp ultra at early crop stage. Highest seed cotton yield (2207 kg /ha) was recorded with application of Dropp ultra @ 250 ml /ha and 2193 kg/ha with application of Dropp ultra @ 200 ml /ha followed by

*Values in parenthesis represents arcsine transformed values.*

### Table 1: Plant Phenology and yield attributes of cotton as influenced by defoliants at different intervals (Pooled means).

| Treatment           | % Defoliation | No of bolls/plant | No of bolls bursted after Spray | Seed Cotton Yield (Kg/ha) | Earliness Index | Harvest Index |
|---------------------|---------------|-------------------|--------------------------------|----------------------------|-----------------|--------------|
| NH615               | 92.0(73.61)   | 30                | 25                             | 1855                      | 62.08           | 37.9         |
| Sivanandi           | 87.3(69.72)   | 26                | 21                             | 1736                      | 56.17           | 35.4         |
| LSD (P=0.05)        | 3.2           | 1.8               | 1.7                            | 104                       | 3.4             | 2.1          |
| Ethrel @1500ppm     | 84.3(70.23)   | 25                | 21                             | 1878                      | 67.59           | 36.7         |
| Ethrel @2000ppm     | 87.3(69.16)   | 26                | 20                             | 1981                      | 68.51           | 38.5         |
| Ethrel @3000ppm     | 89.0(72.61)   | 28                | 21                             | 1989                      | 70.07           | 39.2         |
| Dropp Ultra @200ml/ha| 90.0(73.61)  | 29                | 25                             | 2193                      | 73.86           | 42.1         |
| Dropp Ultra @250ml/ha| 92.3(70.94)  | 29                | 27                             | 2207                      | 74.65           | 43.9         |
| Control             | 10.0(18.44)   | 27                | 15                             | 1650                      | 52.78           | 34.4         |
| LSD (P=0.05)        | 3.9           | 1.5               | 0.4                            | 140                       | 3.8             | 2.4          |
| Time of defoliant application |           |                  |                                |                           |                 |              |
| 120 Days after sowing| 87.2(71.24)  | 26                | 19                             | 1645                      | 53.42           | 34.0         |
| 140 Days after sowing| 92.2(72.86)  | 29                | 25                             | 2145                      | 72.25           | 41.4         |
| LSD (P=0.05)        | 3.1           | 1.9               | 1.8                            | 119                       | 3.4             | 2.5          |
Ethrel @ 3000 ppm (1989 kg/ha) which is at par with the treatment Ethrel @ 2000 ppm (1981 kg/ha), while statistically least lint yield (1650 kg/ha) was recorded under control. Earliness index increased by increasing concentration of Dropp ultra and Ethrel. This may be due to increase in concentration of defoliant which led to earlier flowering and boll formation and ultimately ratio of harvestable bolls in first picking increased that contributed to improve earliness index. Earliness index of 74.65 recorded with application of Dropp ultra @ 250 ml/ha and 73.86 with Dropp ultra @ 200 ml/ha

**Effect of application time**

Time of application of defoliant significantly affected the seed cotton yield, earliness index and harvest index (Table 1). In the present study early application (120 DAS) of defoliants at all doses lead to severe shedding of squares, flowers and young bolls. Late application (140 DAS) resulted in significantly better seed cotton yield. Çopur et al. (2010) also found that delaying crop termination with Dropp ultra and roundup defoliants recorded better boll formation and yield than control. One possible explanation is that postponing defoliation allows for more carbon assimilation and partitioning of photo assimilates to develop cotton bolls. However, when the defoliants were applied later, cotton leaves could not be defoliated due to low temperatures prevailed in winter season. Teshaev (2007) found optimal defoliation norm to the cotton plant stimulates comprehensive physiological processes in plant tissue which lead to utilize maximum amount of nutrients and increased the seed weight. Kulvr Singh et al. (2015) reported that both Dropp ultra @200ml/ha or Ethrel @2000ppm at150 days after sowing allowed for manipulation of physiological processes in plant growth and development for more efficient crop management and increased seed cotton yield. Earliness index was significantly higher during defoliant application at 140 days of sowing (72.25) in which maximum number of bursted bolls, resulted in higher seed cotton in first picking.

**Fiber length (mm), fiber fineness (mic) and fiber strength (g tex⁻¹)**

The effect of defoliants on fiber length (mm), fineness (mic) and strength (g tex⁻¹) and uniformity ratio among varieties, treatments and time of application are given in Table 2. Among the two cultivars maximum fiber length was recorded in NH 615 (31.25 mm). Fibre length was not influenced by different defoliants and their doses. However time of defoliant application influenced the fibre length and 28.89 mm length was recorded at application of defoliant at 140 days after sowing, whereas early application of defoliants at 120 days after sowing had a negative effect on fibre development and may cause contraction of fibres and fibre length. Similar results were reported by Karademir et al. (2007) and Denizdururan and Efe (2009).

There were significant differences for fibre fineness or micronaire, among the varieties and treatment combinations. Superior fiber fineness was recorded in NH615 (4.21) compared to Sivanandi (4.11) whereas application of Dropp ultra @250ml/ha at 140 days after sowing recorded (4.15). When defoliants are applied at early stages, micronaire development is arrested and low micronaire can result because of immaturity. Conversely, if applied at later stages resulted in high micronaire. These results are consistent with Snipes and Baskin (1994), Larson et al. (2002) and Gwathmey et al. (2004). The pooled results revealed that the early applications recorded lower micronaire values as compared to all other treatments tested.

There were no significant differences in fiber strength between varieties, defoliant treatments and application time. Early application of defoliants had a negative effect on fibre development, probably causing contraction of fibers. Early defoliation and boll opening can shorten the period of secondary wall deposition and also lead to reduction in the

| Treatment | Fibre length (mm) | Fibre fineness (micronaire) | Fibre strength (g tex⁻¹) | Uniformity ratio % |
|-----------|--------------------|-----------------------------|-------------------------|--------------------|
| Varieties |
| NH615     | 31.25              | 4.20                        | 24.50                   | 47.00              |
| Sivanandi | 30.87              | 3.90                        | 23.90                   | 45.22              |
| LSD (P=0.05) | NS               | 0.09                        | NS                     | 1.2                |
| Defoliant dosage |             |                             |                         |                    |
| Ethrel @1500ppm | 28.06              | 3.57                        | 21.60                   | 43.12              |
| Ethrel @2000ppm | 27.75              | 3.20                        | 21.90                   | 43.51              |
| Ethrel @3000ppm | 28.12              | 3.39                        | 22.50                   | 44.60              |
| Dropp Ultra @200ml/ha | 30.02             | 3.88                        | 22.50                   | 45.42              |
| Dropp Ultra @250ml/ha | 30.21              | 4.01                        | 23.21                   | 46.81              |
| Control   | 27.55              | 3.75                        | 21.90                   | 43.25              |
| LSD (P=0.05) | NS               | 0.12                        | NS                     | 2.9                |
| Time of defoliant application |             |                             |                         |                    |
| 120 Days after sowing | 24.25              | 3.87                        | 22.84                   | 44.21              |
| 140 Days after sowing | 28.89              | 4.15                        | 23.54                   | 46.58              |
| LSD (P=0.05) | 1.2               | 0.08                        | NS                     | 2.7                |
strength (Gormus et al. 2017). Significant variations were observed for uniformity ratio among cultivars, defoliant treatments and application time. Among the cultivars uniformity ratio of (47.00) in NH 61S and (46.81) with Dropp ultra @250ml/ha and (46.58) at 140 days after sowing resulted in significantly greater uniformity values. Michelotto et al., (2013) revealed that the early defoliation negatively affected all agronomic traits, on the contrary using defoliants on timely manner and recommended dose improved the yield and fibre quality.

CONCLUSION
The success of a defoliation program is strongly dependent on favorable environment and crop conditions that prevail. It can be concluded from this study that cotton under high density planting system and defoliation with Dropp ultra @ 250 ml/ha recorded higher yields without deteriorating fibre quality. Defoliating a cotton crop too early or too late may have a negative impact on yield potential and fiber quality.

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