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RESPONSE OF COTTON HYBRIDS TO TIME OF PYRAFLUFEN ETHYL APPLICATION UNDER HIGH DENSITY PLANTING

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ABSTRACT

A field experiment was conducted during *kharif*, 2023 at the College Farm, College of Agriculture, PJTAU, Rajendranagar, Hyderabad, Telangana, to assess the influence of cotton hybrids and timing of Pyraflufen ethyl application on defoliation efficiency, boll opening and seed cotton yield under high-density planting system (HDPS). The study was laid out in a Factorial Randomized Block Design (FRBD) with two Bt cotton hybrids: RCH-929 and RCH-971 as Factor I and four defoliant treatments as Factor II: S_1: Control, S_2: Pyraflufen ethyl @ 1 ml L^{-1} at 60% boll opening, S_3: Pyraflufen ethyl @ 1 ml L^{-1} at 80% boll opening and S_4: Pyraflufen ethyl @ 1 ml L^{-1} at both 60% and 80% boll opening. Results revealed that hybrids did not significantly influence any of the parameters, indicating comparable physiological responses to defoliant spray. However, the timing of defoliant application showed significant effects. Application of Pyraflufen ethyl at 60% boll opening stage (S_2) recorded the highest boll opening percentage (89.3%) and maximum seed cotton yield (2515 kg ha^{-1}), followed by S_3 (80% boll opening), while the lowest yield (1815 kg ha^{-1}) was observed in S_4 despite recording the highest defoliation (92.1%), it led to excessive physiological stress, negatively affecting boll development and yield. The superior performance of the 60% application stage may be attributed to the timely induction of senescence processes, ensuring optimal boll maturation without compromising metabolic balance. The study concludes that a single application of Pyraflufen ethyl @ 1 ml L^{-1} at 60% boll opening is ideal for maximizing boll opening and seed cotton yield in HDPS cotton.

Key words : Boll opening, Defoliation, Hybrids, Pyraflufen ethyl, Seed yield

Introduction

Cotton (*Gossypium hirsutum* L.) is one of the most important commercial fibre crops in the world, often referred to as the "white gold" due to its significant role in the global textile industry and rural economy. India ranks as the largest producer and second largest exporter of cotton globally, with a cultivated area of approximately 12.5 million hectares and production of 33.5 million bales and productivity of 436 kg ha^{-1} (Cotton Corporation of India, 2024). Among the major cotton growing states, Gujarat, Maharashtra and Telangana contribute substantially to national output. The high yielding Bt cotton hybrids exhibit varied morphological traits and phenological behaviours that influence defoliation efficiency and boll maturity synchronization (Nerkar *et al.*, 2017). The selection of appropriate hybrids suited for specific defoliation schedules is thus critical to maximize lint yield and facilitate timely harvesting, especially under high density planting systems (Gunasekaran *et al.*, 2020; Kumar *et al.*, 2021). Timely defoliation in cotton is crucial to facilitate mechanical picking, reduce trash content and enhance lint quality. The physiological crop stage at which defoliants are applied significantly affects boll opening and leaf drop dynamics (Copur *et al.*, 2010; Buttar and Sudeep, 2013). Research has indicated that defoliant efficacy is optimal when applied at 60-80% boll opening, depending on hybrid and environmental conditions (Morgan, 1969; Li *et al.*, 2024). Pyraflufen ethyl, a contact type protoporphyrinogen oxidase (PPO) inhibitor, has emerged as a promising defoliant with rapid action and low residual toxicity (Miura *et al*., 2003; Griffin *et al*., 2010). It induces chlorophyll degradation and cellular membrane damage leading to accelerated leaf senescence. Given the increasing interest in mechanical harvesting and quality fibre production, it becomes imperative to understand the interaction of cotton hybrids with defoliant efficacy at varying crop growth stages. This study was undertaken to evaluate the effect of different hybrids and to identify the most appropriate boll opening stage for Pyraflufen ethyl application to optimize defoliation, boll opening and seed cotton yield.

Materials and Methods

The experiment was carried out at college farm, College of Agriculture, Rajendranagar, PJTAU, Hyderabad. The farm is located at an elevation of 542.3 meters above mean sea level at 17.322069 N latitude, 78.408547 E longitude comes under the Southern Agro-climatic Region of Telangana. The experiment was laid out in Factorial Randomized Block Design (FRBD) with two hybrids as factor I (V_1: RCH-929, V_2: RCH-971) and factor II *i.e.*, S_1: Control, S_2: Pyraflufen Ethyle @1ml L^{-1} spray at 60% boll opening, S_3: Pyraflufen Ethyle @1ml L^{-1} spray at 80% boll opening, S_4: Pyraflufen Ethyle @1ml L^{-1} spray at 60% and 80% boll opening. Cotton crop was sown in *kharif*, 2023 with spacing of 90 cm × 15 cm and Recommended dose of fertilizers (120:60:60 N, P_2O_5 K_2O) was applied in the form of urea, Di- Ammonium phosphate (DAP) and muriate of potash (MOP), respectively. Defoliation percentage, Boll opening percentage was recorded at 15 days after spray in each treatment by using the following formula and seed cotton yield was recorded.

$$\text{Defoliation percentage} = \frac{La - Lb}{La} \times 100$$

Where,

La = Number of leaves before treatment

Lb = Number of leaves after treatment

$$\text{Boll opening percentage} = \frac{Ba - Bb}{Ba} \times 100$$

Where,

Ba = Number of bolls before treatment

Bb = Number of bolls after treatment

Results and Discussion

There was no significant effect of hybrids on the defoliation percentage, boll opening percentage and seed cotton yield indicating a similar response from both RCH-971 and RCH-929 hybrids with application of defoliants at different boll opening stages. This may be attributed to the similar genetic background, compact physiology and maturity duration of both hybrids.

Defoliation percentage

The data pertaining to the defoliation percentage demonstrated in Table 1 indicated that defoliation percentage after 60% boll opening stage was significantly higher with application of Pyraflufen ethyl @1 ml L^{-1} at 60% and 80% boll opening stage (72.1%) and it was on par to Pyraflufen ethyl @ 1 ml L^{-1} at 60% boll opening stage (71.3%) as compared to other two treatments where there was no defoliant applied at that stage (Fig. 1).

Defoliation percentage after 80% boll opening stage, application of Pyraflufen ethyl @ 1 ml L^{-1} at 60% and 80% boll opening stages (S_4) provided significantly higher defoliation percentage (92.1%) and was superior to other

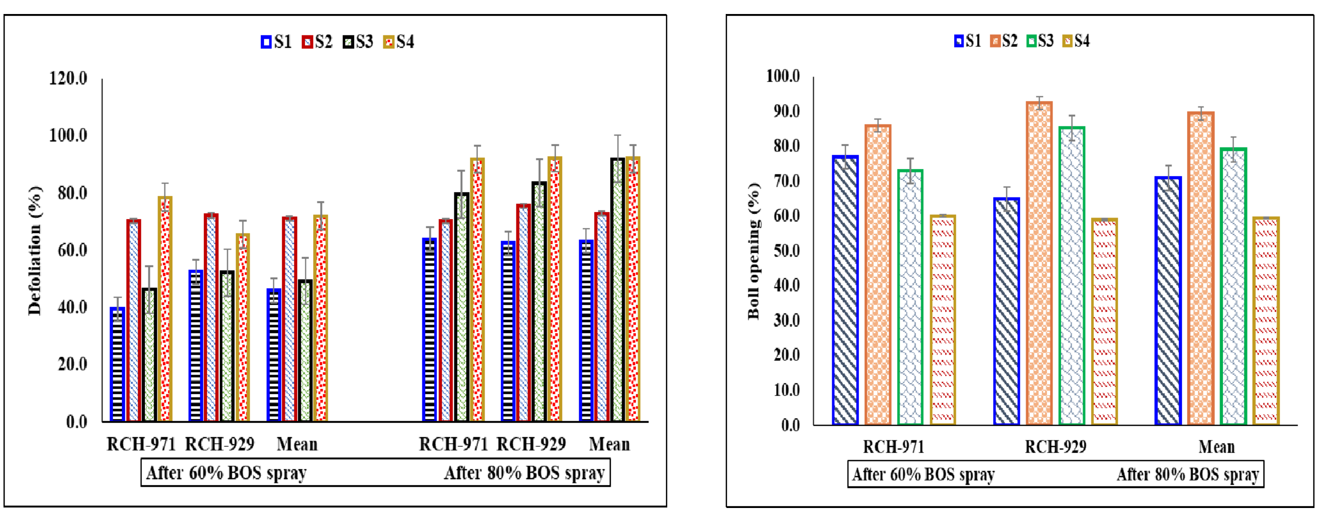

Fig. 1 : Response of cotton hybrids to time of Pyraflufen ethyl application on defoliation percentage and boll opening percentage.

Table 1 : Influence of hybrids and time of Pyraflufen ethyl spray on defoliation percentage of HDPS cotton.

Treatments	No. of leaves before spraying			After 60% boll opening stage spray			After 80% boll opening stage spray		
	RCH - 971	RCH - 929	Mean	RCH - 971	RCH - 929	Mean	RCH - 971	RCH - 929	Mean
S_1: Control	47.3	45.6	**46.5**	39.6 (28.6) *	52.6 (21.6)	**46.1 (25.1)**	64.0 (10.4)	62.6 (8.1)	**63.3 (9.2)**
S_2: Pyraflufen ethyl @1ml L^{-1} at 60% boll opening	44.8	39.6	**42.2**	70.4 (13.3)	72.3 (11.0)	**71.3 (12.1)**	70.4 (3.9)	75.6 (2.7)	**73.0 (3.3)**
S_3: Pyraflufen ethyl @ 1ml L^{-1} at 80% boll opening	46.5	42.1	**44.3**	46.4 (24.9)	52.3 (20.1)	**49.3 (22.5)**	79.7 (5.2)	83.6 (3.2)	**82.0 (4.2)**
S_4: Pyraflufen ethyl @ 1ml L^{-1} at 60% and 80% boll opening	42.8	44.3	**43.6**	78.6 (9.2)	65.6 (15.2)	**72.1 (12.2)**	91.9 (0.8)	92.3 (1.2)	**92.1 (1.0)**
Mean	**45.4**	**42.9**		**58.7 (19.0)**	**60.7 (17.0)**		**76.5 (5.0)**	**78.6 (3.8)**	
				SEm±	**CD**	**Sig.**	**SEm±**	**CD**	**Sig.**
Hybrids				1.58	4.79	NS	1.82	5.53	NS
Treatments				2.24	6.78	S	2.58	7.83	S
T × H				3.16	9.59	NS	3.65	11.07	NS

* Figures in parenthesis are no. of leaves still intact on plant.

treatments. This enhanced defoliation is due to the cumulative effect of two applications, which intensifies oxidative stress and accelerates leaf senescence and abscission. Followed by Pyraflufen ethyl @ 1 ml L^{-1} at 80% boll opening stage (S_3) significantly provided 82.0%, after that S_2: Pyraflufen ethyl @ 1 ml L^{-1} at 60% boll opening stage (73.0%). In both stages control (S_1) recorded lower defoliation percentage (46.1% and 63.3%, respectively). Defoliation is more in S_3 (80% boll opening stage) as compared to S_2 (60% boll opening stage) but observing the no. of leaves still intact on plant it is less in S_2. This corroborates with Ashraf *et al*. (2020) who observed late sprayed paraquat @ 1500 ppm at 150 DAS comparatively registered a higher percentage of leaf fall than the earlier sprayed ones (135 DAS).

Boll opening percentage

Among defoliant treatments, significantly higher boll opening percentage (89.3%) was recorded when Pyraflufen ethyl @1 ml L^{-1} was applied at 60% boll opening stage and it was superior to others. Followed by Pyraflufen ethyl @1 ml L^{-1} applied at 80% boll opening stage given boll opening percentage (79.2%) as a next best treatment (Table 2 and Fig. 1). Pyraflufen ethyl @ 1 ml L^{-1} applied at 60% & 80% boll opening stages provided significantly lower boll opening percentage (59.5%) due to the excessive oxidative stress by twice defoliant application. These results confirm the better performance of the defoliant spray at the 60% boll opening stage which might be attributed to the timely induction of physiological processes like ethylene production and leaf senescence, with promoted efficient boll maturation and opening without inducing excessive stress.

These findings match with results reported by Wright *et al*. (2015), where application of harvest aid materials at 6 to 7 NACB can benefit Pima cotton growers in California as early harvests can be achieved without compromising lint yield or quality. Jajoria *et al*. (2020) revealed that application of Diquat dibromide 24.5 SL W/V at 1105 g a.i. ha^{-1} at 60-70 per cent boll opening stage of cotton crop appears to be promising as it gave significantly higher boll opening.

Seed cotton yield

Among the defoliant treatments, application of Pyraflufen ethyl @1 ml L^{-1} applied at 60% boll opening stage recorded significantly higher seed cotton yield (2515 kg ha^{-1}) superior to other treatments (Table 2 and Fig. 2). Followed by S_3 spaying at 80% boll opening stage (2315 kg ha^{-1}). Whereas defoliant spray at 60% & 80% boll opening stages recorded lower seed cotton yield

Table 2 : Influence of hybrids and time of Pyraflufen ethyl spray on boll bursting percentage and seed cotton yield of cotton.

Treatments	Boll busting percentage			Seed cotton yield (kg ha^{-1})		
	RCH - 971	RCH - 929	Mean	RCH - 971	RCH - 929	Mean
S_1: Control	77.1	65.0	**71.0**	2019	2134	**2077**
S_2: Pyraflufen ethyl @1ml L^{-1} at 60% boll opening	86.0	92.5	**89.5**	2436	2594	**2515**
S_3: Pyraflufen ethyl @ 1ml L^{-1} at 80% boll opening	73.0	85.4	**79.2**	2145	2484	**2315**
S_4: Pyraflufen ethyl @ 1ml L^{-1} at 60% and 80% boll opening	60.1	59.0	**59.5**	1862	1767	**1815**
Mean	**73.8**	**75.3**		**2116**	**2245**	
	SEm±	**CD**	**Sig.**	**SEm±**	**CD**	**Sig.**
Hybrids	1.61	4.88	NS	45.7	138.5	NS
Treatments	2.27	6.90	S	64.6	195.9	S
T × H	3.22	9.76	NS	91.3	277.0	NS

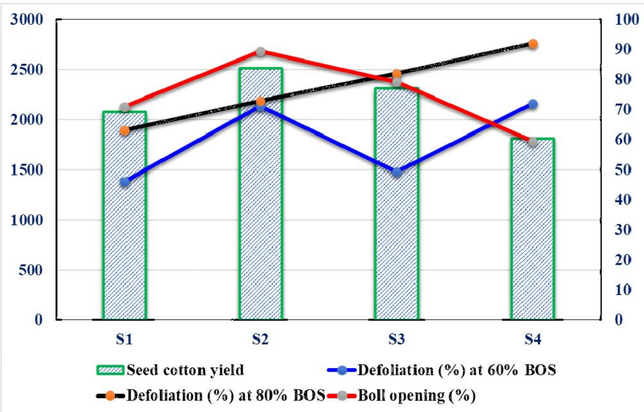

Fig. 2 : Mean performance of HDPS cotton as influenced by time of Pyraflufen ethyl application.

(1815 kg ha^{-1}) than the control (2077 kg ha^{-1}).

Repeated defoliation in S_4 likely resulted in higher oxidative stress, which is reflected by increased SOD activity and more severe reductions in leaf conductance are indicative of stress-induced metabolic disruption. These physiological imbalances may have reduced boll development and seed filling, ultimately decreasing yield. Whereas defoliant spray at 60% boll opening stage produced more yield owing to optimized sink strength and improved boll filling by balancing the hormonal response with moderate leaf fall. Deol and Brar (2011), Awan *et al.* (2012), Gormus *et al.* (2017) and Priyadarshini *et al.* (2023), who also recorded higher seed control yield with defoliant application at 60% boll opening stage.

Conclusion

The present investigation revealed that the hybrid effect (RCH-971 and RCH-929) was not significant, indicating both cultivars responded similarly to defoliant treatments, likely due to comparable maturity and canopy architecture. Among the defoliant treatments, spraying Pyraflufen ethyl @ 1 ml L^{-1} at 60% boll opening stage demonstrated superior performance, recording the highest boll opening (89.3%) and seed cotton yield (2515 kg ha^{-1}), significantly outperforming other treatments and the control. While defoliation was marginally higher with a two-time spray (at 60% and 80% boll opening), this approach led to yield reduction due to increased oxidative stress, disrupted sink-source balance, as reflected by compromised boll filling. Application defoliant (Pyraflufen ethyl @ 1 ml L^{-1}) at 60% boll opening appears optimal, striking a balance between efficient defoliation and physiological readiness of the crop for boll bursting. These insights have direct implications for improving mechanical harvesting readiness, fibre quality and operational efficiency in cotton cultivation, especially under high density planting systems.

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