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Use of Thidiazuron as Harvest-Aid in Early and Late Planted Cotton

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ABSTRACT

The purpose of this research was to determine interactive influence of thidiazuron on defoliation, boll opening and yield of early and late planted cotton. Therefore, a short season cotton cultivar "S-12 "(*G. hirsutum* L.) was planted for two seasons in early and late June in a split plot design and thidiazuron sprayed at the rate of 0, 200, 100 +100 g ha^{-1} at 25±5% open bolls. A degree day above than 100°C was required after thidiazuron application for completion of defoliation process and opening of boll. There was no loss in cotton yield and fibre quality both in early and late sown crop with thidiazuron as harvest aid. The atmospheric minimum and maximum temperatures of 16 and 30°C, respectively, were found conducive for inducement of defoliation process.

Key Words: Cotton; Defoliation; Thidiazuron; Degree days; Seed cotton

INTRODUCTION

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 & Hayes, 1997; Kerby *et al.,* 1984; Malik & Din, 1997). The success of defoliation process depends on the maturity of cotton crop and prevailing weather conditions at the time of application. Brown and Hyer (1954, 1956) reported that defoliant efficiency was associated with both the number of mature bolls and mature leaves at the time of chemical termination. The premature defoliation at 20% opened bolls damaged fibre quality and reduced yield. The night temperature of 16°C has been found most suitable for defoliation (Cathey, 1986). Cotton defoliation is often practiced when 60% of bolls are opened to avoid loss in yield and fibre quality (Snipes & Baskin, 1994). There may be circumstances, when crop is planted late and harvest is desired to avoid frost damage and timely sowing of relay crop. Relatively, little information has been published on this aspect of cotton defoliation. The objectives of this research were to compare the effectiveness of thidiazuron as defoliant in early and late planted cotton and relate these effects to crop maturity and temperature regimes prevalent during and after treatments.

MATERIALS AND METHODS

Cotton cultivar S-12 (*G. hirsutum* L.) was planted during 1991 and 1992 at experimental farms of Central Cotton Research Institute, Multan, Pakistan to study its response to thidiazuron foliar spray. The treatments (Table I) were arranged in split plot design with date of sowing in mainplots. The experiment was replicated four times. Crop was planted at density of 35000 plants ha^{-1} at a plant configuration of 75 cm between rows and 30 cm between plants in the rows. Crop was irrigated and applied 150 kg N and 50 kg P_2O_5 ha^{-1}. Crop was protected from insects damage at economic threshold level (ETL) throughout the growing season. The crop was sprayed with knapsac sprayer using two nozzles row^{-1} and operated at 4 km h^{-1} and maintaining 275 kPa pressure to deliver 200 L ha^{-1} of solution. Plot size in each replication was 8 m wide and 30 m long.

Table I. Detail of treatments

Date of planting	Thidiazuron dose	Date of spray	
	(g ha^{-1})	26th October	10th November
5th June	Check	-	-
	200*	+	-
	100+100**	+	+
25th June	Check	-	-
	200	+	-
	100+100	+	+

*Single dose; **Two equal split doses

Ten plants were tagged at random in each plot on the day of treatment for recording data on leaf defoliation, boll dehiscence and yield components analysis. Seed cotton yield was hand picked in each plot and total yield calculated on area basis. The combined analysis of variance was calculated for two seasons for each of factors measured as per methods of Steel and Torrie (1980). Daily maximum and minimum temperatures were measured at instrument shelter of the experimental farm. Cumulative degree-days were calculated as described by Malik (1991) using a base temperature of 15.6 °C (Table II).

Table II. Crop calendar, temperature regimes and degree days during crop season

Varieties	Early planted	Late planted
Date of planting	5th June	25th June
Date of thidiazuron spray	26th October	26th October
Open bolls (%) at defoliation	32	25
Degree-days (°C) from planting to thidiazuron application	1950	1624
Degree-days (°C) from planting to crop harvest	2066	1740
Avg. maximum temp. (°C) 0-3 DAT	31	31
0-10 DAT	30	30
0-20 DAT	29	29
0-30 DAT	28	28
0-40 DAT	27	27
Daily maximum temp. (°C) on 26th October	32	32
27th October	31	31
28th October	30	30
29th October	30	30
30th October	30	30
31st October	30	30
1st November	30	30
Avg. minimum temp. (°C) 0-3 DAT	17	17
0-10 DAT	16	16
0-20 DAT	15	15
0-30 DAT	13	13
0-40 DAT	13	13
Daily minimum temp. (°C) on 26th October	17	17
27th October	17	17
28th October	17	17
29th October	17	17
30th October	17	17
31st October	16	16
1st November	16	16
Avg. relative humidity (%) 0-3 DAT	81	81
0-10 DAT	85	85
0-20 DAT	85	85
0-30 DAT	86	86
0-40 DAT	86	86
Daily relative humidity (%) on 26th October	79	79
27th October	75	75
28th October	89	89
29th October	90	90
30th October	95	95
31st October	95	95
1st November	89	89

RESULTS AND DISCUSSION

Cotton defoliability was influenced by several factors like type of chemical, rate of application, crop coverage, maturity of the plant and weather conditions. Because of different sowing dates cotton crop had different levels of maturity when sprayed with thidiazuron. Crop completed its defoliation in 10 days after treatment (Table III). The magnitude and level of response was almost similar in both early and late sown crop. These data suggest that temperature prevailing at the time of defoliant application played a significant role in inducement of defoliation. The minimum temperature of 16°C and a diurnal temperature of

Table III. Leaf defoliation (%) after thidiazuron application

Thidiazuron (g ha^{-1})	Early June Planting			Late June Planting		
	Leaf defoliation (%)					
	Days after treatment			Days after treatment		
	3	10	20	3	10	20
Check	3	10	65	4	9	62
200	5	100	100	6	100	100
100+100	5	100	100	6	100	100
Statistical S.	S.	H.S.	H.S.	S.	H.S.	H.S
S.E. ±	0.35	0.22	0.75	0.36	0.22	0.82

S=significant; HS= Highly significant

24°C have been found critical for minimal leaf response to most defoliants (Cathey, 1985; 1986). In this experiment, maximum and minimum temperatures that occurred during the seven days following thidiazuron treatment were above the threshold limits. Degree-days unit of above than 100°C were received during defoliation period to complete the process. The single and split application of 200 g ha^{-1} of thidiazuron was found equally effective to induce defoliation. Thidiazuron accelerates boll dehiscence by increasing ethylene level in cotton leaves (Suttle, 1985). Light penetration is also improved by leaf removal. These crop conditions lead to early maturity and opening of bolls (Malik *et al.,* 1991). Thidiazuron accelerated boll opening almost at same rate in both early and late planted cotton (Table IV). This implies that warm temperatures played dominant role to stimulate defoliation and boll opening processes. The role of crop maturity was of lesser degree than that of temperatures not withstanding differences in crop ontogeny. Cotton crop after attaining heat units of > 1600°C at Multan is reproductively mature and has entered its senescent phase. However, cotton leaves are physiologically active enough at mid maturity stage to allow leaf defoliation and boll dehiscence. Cathey (1986) stated that condition of plant and prevailing weather at time of application are the major factors that limit efficiency of defoliation process. The defoliant efficiency is highest when moisture level of leaves is high, and when both temperature and humidity are high. These conditions were fully met in prevailing crop at the time of defoliant application. The primary task of an efficient defoliation programme is timely harvest and no loss in yield and fibre quality.

Data presented in Table V indicate no such loss in

Table IV. Boll opening (%) after thidiazuron application

Thidia-zuron (g ha^{-1})	Early- June planting					Late -June planting				
	Boll Opening (%)									
	Days after treatment					Days after treatment				
	3	10	20	30	40	3	10	20	30	40
Check	31	38	80	84	90	21	35	67	76	87
200	33	53	88	95	100	27	45	81	91	100
100+100	32	50	87	93	100	27	42	80	90	100
Stat. Sign.	NS	HS	HS	HS	HS	NS	NS	HS	HS	HS
S.E.±	0.57	1.01	0.87	1.25	0.97	0.61	1.03	0.95	1.07	0.85

Table V. Effects of thidiazuron on seed cotton yield and its components on early and late planted cotton

Yield parameters	Thidiazuron (g ha $^{-1}$)							
	Check		200		100+100		Standard Error±	
	Early June	Late June	Early June	Late June	Early June	Late June	Early June	Late June
Seed cotton kg ha $^{-1}$	2286	2544	2305	2577	2302	2569	28.9 N.S.	36.8 N.S
Harvested boll plant $^{-1}$	27	26	27	26	26	26	0.39 N.S.	0.36 N.S.
Bolll wt.(g)	4.01	4.01	4.02	4.02	4.00	4.00	0.03 N.S.	0.02 N.S.
Lint (%)	39.60	39.42	39.64	39.46	39.65	39.56	0.24 N.S.	0.20 N.S.
Seed Index (g)	9.6	9.6	9.5	9.7	9.0	9.6	1.05 N.S.	0.05 N.S.
Seed germination (%)	76	74	72	66	70	64	1.31 N.S.	1.21 N.S.

Table VI. Effects of thidiazuron application on fiber quality

Thidiazuron (g ha^{-1})	Early June planting				Late June planting			
	Staple length (mm)	Fineness µg inch^{-1}	Strength 000lbs inch^{-2}	Uniformity ratio (%)	Staple length (mm)	Fineness µg inch^{-1}	Strength 000 lbs inch^{-2}	Uniformity ratio (%)
Check	27.0	4.61	94.2	46.94	26.6	4.45	93.0	47.81
200*	26.8	4.53	93.8	46.90	26.4	4.30	92.8	47.78
100+100**	26.9	4.58	94.4	46.48	26.5	4.37	92.8	47.31
Stat. Significance	N.S.	N.S	N.S	N.S	N.S	N.S	N.S.	N.S.
S. E. ±	0.34	0.11	0.87	0.41	0.29	0.12	0.81	0.39

yield and its components due to thidiazuron treatments. These results verify the earlier findings on cotton defoliation with respect to thidiazuron (Malik *et al*., 1991; Malik & Din, 1997). The most important factor to be considered in the practice of chemical defoliation is the stage of crop maturity. The time of defoliation in present studies coincided with the cut out phase of cotton crop. The test cultivar has determinate fruiting habit and early maturity. The bolls had attained physiological maturity by late October and 20 to 30% bolls were opened at defoliation time. These crop conditions did not result in yield loss. Kerby (1988) stated that with stimulation of defoliation process, leaves transport most of their nutrients and metabolites to developing bolls. Thus, there is no loss in yield "per se" due to defoliation provided bolls have attained physiological maturity.

Cotton end use depends on fibre quality. Any agronomic practice, which brings deterioration in fibre quality is not desirable. Data presented in Table V shows no deleterious effects of the thidiazuron on fibre quality. The immature cotton bolls were shed with thidiazuron and hence were not harvested at the end of season.

Brown and Hyer (1956) reported that adverse effects of defoliants and desiccants are limited to those bolls that are less than 35 days old. Further, environment accounted more in fiber quality variations than defoliants. Results from this study indicate that thidiazuron defoliant did not cause yield loss or deterioration in fiber quality in a physiologically matured crop.

It is recommended that cotton crop having 25±5% open boll may be sprayed with 200 g ha^{-1} thidiazuron without loss in seed cotton and fibre quality. The atmospheric minimum and maximum temperatures of 16 and 30°C were found conducive for inducement of defoliation process.

REFERENCES

Brown, L.C. and C.L. Rhyne, 1954. Chemical defoliation of cotton: The influence of boll maturity on the defoliability of species and varieties of cotton. *Agron. J.,* 46: 128–32.

Brown, L.C. and A.H. Hyer, 1956. Chemical defoliation of cotton: Effects of premature defoliant and dessicant treatments on boll components, fibre properties, germination and yield of cotton. *Agron. J.,* 48: 50–5.

Cathey, G.W., 1985. Conditioning cotton for increased response to defoliant chemicals. *Field Crop Res.*, 10: 347–53.

Cathey, G.W., 1986. Physiology of defoliation in cotton production. *In:* J.R. Mauney and J.M. Stewart (Eds.), *Cotton Physiology,* pp: 143–54. The Cotton Foundation, Memphis, T.N. USA.

Gwathmey, C.W. and R. Hayes, 1997. Harvest aid interactions under different temperature regimes in field grown cotton. *J. Cotton Sci.*, 1: 1–9.

Kerby, T.A., 1988. Cotton physiology and cotton harvest aid. *Cotton Consultant Conf.*, pp: 1–7. ICI. America Inc.

Kerby, T.A., S. Johnson and H. Yamada, 1984. Efficacy of cotton defoliants. *California Agric.,* 38: 24–7.

Malik, M.N., 1991. Heat unit, crop phenology and compensation in cotton. *The Pakistan Cottons,* 35: 123–8.

Malik, M.N., S. Din and M.I. Makhdum, 1991. Accelerated boll dehiscence with thidiazuron. *Tropic. Agric.*, 68: 149–50.

Malik, M.N. and S. Din, 1997. Efficacy of thidiazuron defoliant in cotton cultivars varying in maturity. *The Pakistan Cottons,* 41: 36–42.

Snipes, C.E. and C.C. Baskin, 1994. Influence of early defoliation on cotton yield, seed quality and fibre properties. *Field Crop Res.*, 37: 137–43.

Steel, R.G.D. and J.H. Torrie, 1980. *Principles and Procedures of Statistics.* McGraw–Hill Book Co., New York.

Suttle, J.C., 1985. Involvement of ethylene in the action of the cotton defoliant thidiazuron. *Plant Physiol.*, 78: 272–6.

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