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EFFICACY OF HARVEST-AID DEFOLIANTS ON YIELD OF SEED COTTON (*GOSSYPIUM HIRSUTUM* L.)

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Abstract

Field experiments were conducted to determine the effect of different harvest-aid defoliants, their application rates and time of application [140 and 150 days after sowing (DAS)] on yield of seed cotton (*Gossypium hirsutum* L.). MRC7361BGII (3171.8 kg/ha) and MRC7017BGII (3083.3 kg/ha) produced significantly higher yield as compared to F1861 (2454.9 kg/ha). Improved water and fertilizer use efficiency coupled with better Benefit: Cost (B : C) ratio for Dropp ultra 200 ml/ha at 150 DAS clearly indicated its superiority over other treatments. Dropp ultra showed potential to improve yield besides promoting crop earliness while keeping vegetative and reproductive growth in harmony.

The cotton plant is a perennial with an indeterminate growth habit and reputed to have the most complex growth habit of all major row crops (Oosterhuis 1999). One challenge of producing cotton (*Gossypium hirsutum* L.) in the north-western Indian cotton belt is to get the crop matured within a defined period prior to commencement of *Rabi* season in November. In this region, producers seek to shift cotton from vegetative to reproductive growth in mid-season to assure adequate time for bolls to mature and consequently timely sowing of wheat. Use of harvest-aid defoliants may be helpful in this regard. In developed countries, defoliants have been widely used in cotton production for adjusting plant growth and improve lint yield and fiber quality (El-Kassaby and Kandil 1985, Larson *et al*. 2002). In the present work, it was intended to study the effect of harvest-aid defoliants on seed cotton yield and also identify suitable defoliant with optimum dose along with ideal time of application to realize high productivity and to study their economic viability.

The experiment was conducted during *Kharif* 2011 and 2012 at Punjab Agricultural University, Regional Research Station, Faridkot which lies in Trans-Gangetic agro-climatic zone, representing the Indo-Gangetic alluvial plains ($30^0$40'N and $74^0$44 'E) of Punjab situated at 200 m above mean sea level. The soil of the experimental field was sandy loam, with normal pH (8.04), EC (0.22 dS/m), O.C (0.51%), medium in available P (16 kg/ha) but high in available K (515 kg/ha). The experiment comprising of three high-yielding cultivars (F1861, MRC7361BGII and MRC7017BGII) in main, four defoliants [Control; Dropp ultra i.e {Thiadiuron 36% SC + Diuron 18% SC} 200 ml /ha; Dropp ultra 225 ml/ha and Ethrel {2-chloro ethyl phosphonic acid} @ 2000 ppm] in sub and two times of application (140 and 150 DAS) in sub sub plots was conducted in split plot design replicated thrice. Total amount of rainfall was 575.8 and 223.6 mm for the year 2011 and 2012, respectively. Total rainy days (41) were higher during 2011 as compared to only 28 days in the year 2012. A total of 6 and 7 irrigations were applied during 2011 and 2012, respectively to raise the crop successfully. A maximum temperature of 40.9^0C was recorded in May 2011, while June (40.7^0C) was the hottest month in 2012. Sowing was performed as on

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16.5.2011 and 17.5.2012 at a uniform row spacing of 67.5 cm. Each plot size measuring 4.05 × 6 m had 54 plants (67.5 × 75 cm) per treatment. A recommended fertilizer dose of 150 kg N, 30 kg P_2O_5, 50 kg K_2O and 25 kg $ZnSO_4$ (21%) per hectare was uniformly applied (Anon. 2013). All other agronomic practices were followed as per recommended package of practices. Dropp ultra concentration of 0.066 and 0.075%, respectively for 200 and 250 ml/ha were made and delivered uniformly using a knapsack sprayer with water @300 l/ha. Seed cotton yield (Kg/ha) was recorded from whole plot excluding border rows. Water and fertilizer use efficiency was worked out for each year by dividing the seed cotton yield with total amount of irrigation water and fertilizer applied for the respective parameter. Production cost was calculated by adding cost of all the fixed inputs (i.e. pre-sowing tillage operations, sowing, interculture, fertilizers, pesticides and other chemicals, labour used for irrigation, sprays and finally picking etc.). Economics was calculated on the basis of prevailing market price of inputs and seed cotton. The data were analyzed statistically as per the standard procedure (Cheema and Singh 1991). Pooled means have been used to discus results.

Defoliation in cotton plant depends mainly on environmental, as well as genetic factors and cultivation techniques (Whitwell *et al.* 1987). The pooled results (Table 1) revealed that MRC7361BGII (3171.8 kg/ha) and MRC7017BGII (3083.3 kg/ha) produced significantly higher seed cotton yield (SCY) as compared to F1861 (2454.9 kg/ha) due to better bolls/plant and boll weight. Significantly higher fertilizer use efficiency (FUE) by 29.1 and 25.5 per cent was recorded under MRC7361BGII (6.78) and MRC7017BGII (6.59) as compared to F1861 (5.25). Likewise, water productivity (WP) was clearly in favour of MRC7361BGII (655.9) and MRC7017BGII (637.6) as compared to F1861 (506.2). Cost of cultivation in case of F1861 (₹25252 /ha) was significantly low primarily due to low seed cost of variety as compared to other *Bt* hybrids and also low SCY as a result of which less picking labour was employed. Statistically better net returns clearly reflected superiority for MRC7361BGII (₹75544 /ha) and MRC7017BGII (₹72931 /ha). Furthermore, an improved B : C ratio in case of MRC7361BGII (2.50) and MRC7017BGII (2.44) over that of F1861 (2.27) substantiated this finding (Table 2). Nagwekar *et al.* (1984) also observed variability among cotton varieties in respect of yield and fiber quality characteristics with defoliation treatments. Thakral *et al.* (1991) reported similar findings.

Dropp ultra 200 ml/ha exhibited significantly better SCY (3111.6 kg /ha) as compared to higher dose of 225 ml/ha (2674.5 kg/ha) as well as Ethrel 2000ppm (2948.3 kg /ha) and control (2878.9 kg /ha). Pooled data indicated increase in SCY by 8.1, 16.3 and 5.53 per cent over control, Dropp ultra 225 ml/ha and Ethrel, respectively (Table 1). However, Weir and Gaggero (1982) reported 51% open bolls, compared with only 22% for control with ethrel application. Application of Dropp ultra 225ml/ha resulted in severe shedding of leaves, young flowers and fruiting bodies and even some developing bolls, which lead to significant reduction in seed cotton as well as lint yield. FUE was also significantly reduced with Dropp ultra 225 ml/ha (5.72) as compared to all other treatments. However, significantly highest FUE (6.65) was observed with Dropp ultra 200 ml/ha, which indicated its positive influence on SCY and other monetary parameters. Water productivity also exhibited strong favor for Dropp ultra 200 ml/ha (643.1) followed by Ethrel (609.2) and control (594.6). Statistically least WP ($552.7 g/m^3$) was recorded with the application of Dropp ultra225 ml/ha owing to reasons mentioned above. Significantly highest (₹29398/ha) and lowest (₹27769/ha) cost of cultivation was recorded with Dropp ultra 200ml and 225ml/ha, respectively. This was directly related with SCY and labour charges associated with the picking. Significantly highest net returns of ₹74682/ha were recorded with application of Dropp ultra 200 ml/ha followed by Ethrel (₹69846/ha), control (₹67806/ha) with statistically least value (₹61701/ha) under Dropp ultra 225 ml/ha. Better B:C ratio with Dropp ultra 200 ml (2.55) and Ethrel (2.43) over Dropp ultra 225 ml/ha (2.23) clearly indicated their

Table 1. Yield, fertilizer use efficiency and water productivity under different treatments.

Treatments	Seed cotton yield (kg/ha)			Lint yield (kg/ha)			Seed yield (kg/ha)			FUE (kg SCY/kg fert. applied)			Water productivity (g/m^3)		
	2011	2012	Pooled	2011	2012	Pooled	2011	2012	Pooled	2011	2012	Pooled	2011	2012	Pooled
Genotype															
F1861	2430.4	2479.5	2454.9	749.4	738.0	743.8	1680.9	1741.4	1711.2	5.19	5.30	5.25	540.1	472.3	506.2
MRC7361BGII	3265.6	3078.0	3171.8	1025.4	933.5	979.5	2240.1	2144.4	2192.3	6.98	6.58	6.78	725.6	586.2	655.9
MRC7017 BGII	3166.2	3000.4	3083.3	988.7	904.8	946.8	2177.5	2095.6	2136.6	6.77	6.41	6.59	703.6	571.5	637.6
CD (0.05)	**256.2**	**295.1**	**162.3**	**80.4**	**90.6**	**50.3**	**177.2**	**205.2**	**112.6**	**0.54**	**0.63**	**0.34**	**56.9**	**56.2**	**33.3**
Defoliant spray															
Control	2916.2	2841.7	2878.9	904.5	850.3	877.4	2011.6	1991.4	2001.5	6.23	6.07	6.15	648.0	541.2	594.6
Drop ultra @ 200 ml/ha	3175.9	3047.3	3111.6	993.8	920.7	957.3	2182.1	2126.6	2154.4	6.79	6.51	6.65	705.7	580.4	643.1
Drop ultra @ 225 ml/ha	2725.1	2623.9	2674.5	855.1	795.3	825.2	1870.0	1828.5	1849.3	5.82	5.61	5.72	605.5	499.8	552.7
Ethrel @ 2000 ppm	2999.0	2897.6	2948.3	931.4	868.8	900.1	2067.5	2028.7	2048.1	6.41	6.19	6.30	666.4	551.9	609.2
CD (0.05)	**140.4**	**169.6**	**106.3**	**45.8**	**52.6**	**33.6**	**96.2**	**118.4**	**73.6**	**0.30**	**0.36**	**0.22**	**31.2**	**32.3**	**21.6**
Time of application															
140 DAS	2823.4	2754.6	2789.0	878.0	827.3	852.6	1945.3	1927.3	1936.4	6.03	5.89	5.96	627.4	524.6	576.1
150 DAS	3084.7	2950.7	3017.7	964.4	890.3	927.4	2120.2	2060.3	2090.3	6.59	6.31	6.45	685.4	562.0	623.8
CD (0.05)	**101.8**	**119.5**	**76.4**	**31.3**	**36.4**	**23.4**	**71.5**	**83.9**	**53.7**	**0.21**	**0.25**	**0.16**	**22.6**	**22.7**	**15.6**

Table 2. Effect of different treatments on economic indices.

Treatments	Cost of cultivation (₹/ha)			Gross returns (₹/ha)			Net returns (₹/ha)			B : C ratio		
	2011	2012	Pooled	2011	2012	Pooled	2011	2012	Pooled	2011	2012	Pooled
Genotype												
F1861	21911	28593	25252	73541	89264	82303	53430	60671	57051	2.43	2.11	2.27
MRC7361BGII	26716	34236	30476	101233	110808	106021	74516	76572	75544	2.77	2.22	2.50
MRC7017 BGII	26418	33887	30152	98153	108016	103084	71734	74129	72931	2.70	2.18	2.44
CD (0.05)	**770**	**1328**	**636**	**7947**	**10624**	**5509**	**7175**	**9295**	**4877**	**0.20**	**NS**	**0.12**
Defoliant spray												
Control	24901	32189	28545	90401	102303	96352	65499	70114	67806	2.61	2.17	2.39
Drop ultra @ 200 ml/ha	25681	33114	29398	98455	109705	104080	72774	76590	74682	2.81	2.30	2.55
Drop ultra @ 225 ml/ha	24328	31209	27769	84478	94462	89470	60149	63253	61701	2.45	2.01	2.23
Ethrel @ 2000 ppm	25150	32440	28795	92969	104313	98641	67819	71872	69846	2.67	2.20	2.43
CD (0.05)	**421**	**763**	**401**	**4352**	**6108**	**3620**	**3931**	**5344**	**3202**	**0.11**	**0.12**	**0.08**
Time of application												
140 DAS	24623	31797	28210	87526	99167	93347	62903	67370	65136	2.53	2.10	2.31
150 DAS	25407	32679	29043	95625	106225	100925	70218	73545	71881	2.74	2.24	2.49
CD (0.05)	**305**	**537**	**301**	**3156**	**4303**	**2599**	**2850**	**3765**	**2299**	**0.07**	**0.08**	**0.05**

economic superiority (Table 2). Lint yield was statistically improved under later (927.4 kg/ha) as compared to early application (852.6 kg/ha) primarily due to better boll retention and consequently less shedding under later application. Similar results were reported by (O_lakçi and Kaynak 1992, Locke *et al*. 1995 and Faircloth *et al*. 2004).

In the present studies, early application (140 DAS) lead to severe shedding of young squares, flowers, fruiting bodies and even younger bolls. Therefore, significantly better SCY was observed with later application at 150 DAS (3017.7 kg/ha) over the early application (2789.0 kg/ha). These results showed that SCY was significantly and negatively affected by early defoliation. One possible explanation is that postponing defoliation allows for more carbon assimilation and partitioning of photo assimilates to develop cotton bolls. These results are in agreement with findings of other workers (Snipes and Baskin 1994, Larson *et al.* 2002, Çiçek *et al.* 2003 and Karademir *et al.* 2007). Çopur *et al.* (2010) also found that delaying crop termination with Dropp ultra and Round up defoliants recorded better boll formation and yield than control. Significant improvement in FUE (6.45) and WP (623.8) in delayed application at 150 DAS of various harvest-aid defoliants clearly supported enhanced SCY over the early application. Though cost of cultivation in later application was merely higher by ₹833/ha primarily owing to high picking charges for enhanced SCY but net returns indicated an additional benefit of ₹6745/ha. Significant improvement in B : C ratio under later (2.49) over the earlier (2.31) application substantiated these findings (Table 2). It is concluded that application of Dropp ultra 200 ml/ha at 150 DAS can promote earliness in cotton while maintaining an equilibrium in vegetative and reproductive growth and therefore, should be considered a useful production practice for enhancing seed cotton yield under semi-arid conditions.

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