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Effect of chemical defoliation on boll opening and yield of cotton

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Abstract

A field experiment was carried out for two consecutive years *kharif*, 2014 and 2015 at instructional farm of Rajasthan College of Agriculture, Udaipur, Rajasthan to study the effect of different defoliant at different doses on cotton and residual effect on succeeding greengram crop. The experiment laid out on sandy clay loam soil by adopting randomized block design which included four replication and seven treatments viz. Untreated check, Diquat dibromide 24.5 SL W/V 551.25 g a.i. ha⁻¹ (2250 ml/ha), Diquat dibromide 24.5 SL W/V 735 g a.i. ha⁻¹ (3000 ml/ha), Diquat dibromide 24.5 SL W/V 918.75 g a.i. ha⁻¹ (3750 ml/ha), Diquat dibromide 24.5 SL W/V 1102.5 g a.i. ha⁻¹ (4500 ml/ha), Paraquat dichloride 24 SL 300 g a.i. ha⁻¹, (1250 ml/ha) Mepiquat chloride 5%AS 62.5 g a.i. ha⁻¹ (1250 ml/ha). Variety Super Mallika was taken during *kharif* season as test crop. Result 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 treatment as it gave significantly higher defoliation, boll opening and seed cotton yield with no phytotoxic effects on cotton bolls and residual crop.

Keywords: Diquat dibromide, doses, greengram

Introduction

Cotton is an important fibre crop of global significance, which is, cultivated in tropical and sub-tropical regions of more than seventy countries the world over. The major producers of cotton are China, India, USA, Pakistan, Uzbekistan, Argentina, Australia, Greece, Brazil, Mexico, and Turkey. These countries contribute about 85% to the global cotton production. India has the largest acreage (11.87 m. ha) under cotton at global level and has the productivity of 484 kg Lint /ha and ranks second in production 338 lakh bales after China during 2015-16 (Anonyms, 2017) [2]. Cotton plays a key role in the National economy in terms of generation of direct and indirect employment in the Agricultural and Industrial sectors. Textiles and related exports of which cotton constitutes nearly 65% account for nearly 33% of the total foreign exchange earnings of our country which at present is around 17 billion dollars with a potential for a significant increase in the coming year.

Defoliation is an important management practice associated with high yield and high quality of cotton. Defoliation allows earlier harvest than if the crop matured naturally, but it can reduce yield and alter fiber quality if the application of the harvest aid is premature (Snipes and Baskin 1994) [11]. Therefore, producers attempt to optimize the timing of harvest-aid applications by maximizing the number of young bolls that are mature and harvestable without sacrificing the yield and quality of older bolls (Abd-El-Aal *et al.* 1990 and Larson *et al.* 2002) [1, 8]. Many variables determine the optimum defoliation timing for cotton grown in different area.

Chemical defoliant are designed to alter the hormonal balance in the crop to enhance the natural process of defoliation and boll opening (Ayala and Silvertooth, 2001) [3]. The manipulation of these hormonal balances comes about through the application of a chemical defoliant or desiccant. Many of the chemical defoliant and boll openers in use today (Wang and Norton, 2012) retard the production of auxin class hormones while stimulating the production of ethylene and abscisic acid (ABA) in the plant. This in turn results in the production of enzymes necessary for the degradation of cellular components and to the formation of the abscission layer and eventual leaf drop (Ayala and Silvertooth, 2001) [3].

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Since the process of defoliation and boll opening is the enhancement of a natural process, the crop must still be physiologically active for effective defoliation to occur. The crop should also be heading towards senescence and all harvestable bolls mature.

Singh (2013) ^[10] reported that cotton growers were keen to improve profit margins by adopting improved cotton production practices while maintaining yield. Cotton has a continuous flowering and fruit formation order which changes depending on the cotton genotypes and environmental conditions. Therefore, managing earliness involves limiting cotton's vegetative growth with cultivar selection and use of plant growth regulators (PGRs)/ harvest-aid defoliant (Stewart, 2000) ^[12]. Mechanized picking also requires application of harvest-facilitating defoliant to shed leaves before harvesting at an appropriate time and to ensure clean and smooth picking of seed cotton. Chemicals have been widely used in developed nations for cotton production in an attempt to adjust plant growth and to improve lint yield and fibre quality (Faircloth., 2004) ^[5]. Researchers have conducted various studies on defoliation using different chemicals and defoliation methods (Karademir, 2007) ^[6]. In this regard, a study was conducted to find out the effect of new defoliant on boll opening and yield of cotton and residual effect on greengram.

Materials and Methods

A field experiment was conducted during *kharif*, 2014 and 2015 at the Instructional Farm, Department of Agronomy, Rajasthan College of Agriculture, MPUAT, Udaipur. It is situated in the lap of Aravalli hills at 24°35' N latitude and 74°42' E longitude with an altitude of 579.50 meters above mean sea level. The experimental site is characterized by typical sub-humid climatic conditions with mild winters and moderate summers. The soil of the experimental site was clay loam in texture, slightly alkaline (pH 7.8) in reaction, medium in available nitrogen (275.1 kg/ha), medium in available

phosphorus (20.69 kg P/ha) and high in potassium (301.1 kg/ha) status.

The experiment comprising 7 treatments was laid out in randomized block design with 4 replications. After opening furrows at 90 cm, sowing was done manually on the 14th July in the year 2014 and the 07th July in the year 2015 by placing two seeds at 90 cm spacing in each row. Bt cotton variety bunny was used as test crop. Thinning was done 15 days after sowing in order to remove extra plants. Recommended packages of practices were adopted in raising the crops. Foliar spray of Mepiquat chloride was done at flowering stage whereas rest of the treatments were applied at 60-70% boll opening stage of the crop.

For residual studies, mungbean variety SML-668 was sown as test crop in the same lay out at a spacing of 30 cm during 2015 and 2016. Thinning was done in the crop at 15 DAS by keeping plant to plant spacing of 10 cm.

Results and Discussion

Effect on leaf defoliation

Application of Diquat dibromide 24.5 SL W/V at 1102.5 g a.i. ha⁻¹ recorded significantly higher per cent of leaf defoliation over untreated check (Table-1), Diquat dibromide 24.5 SL W/V at 551.25 g a.i. ha⁻¹, Diquat dibromide 24.5 SL W/V at 735 g a.i. ha⁻¹ and Mepiquat chloride 5% AS 62.5 g a.i. ha⁻¹ in the crop after 5 and 10 days of treatment application during the year 2014-15. Whereas, 15 and 20 days after application of defoliant, the treatments Diquat dibromide 24.5 SL W/V at 1102.5 g a.i. ha⁻¹ gave significantly higher per cent defoliation over all other treatments.

In the year 2015-16, application of Diquat dibromide 24.5 SL W/V at 1102.5 g a.i. ha⁻¹ resulted significantly higher per cent leaf defoliation observed at 5, 10, 15 and 20 days after treatment application. Further, application of Diquat dibromide 24.5 SL W/V at 1102.5 g a.i. ha⁻¹ gave 97.99 per cent defoliation at 20 days after treatment during 2015-16.

Table 1: Effect of defoliant on leaf defoliation (per cent)

Treatments	2014-15				2015-16			
	Days after treatment				Days after treatment			
	5	10	15	20	5	10	15	20
1. Untreated check	30.46	32.84	35.36	46.39	30.29	29.86	36.25	46.09
2. Diquat dibromide 24.5 SL W/V 551.25 g a.i. ha ⁻¹ (2250 ml/ha)	42.23	47.26	64.45	71.45	38.56	53.78	69.45	74.23
3. Diquat dibromide 24.5 SL W/V 735 g a.i. ha ⁻¹ (3000 ml/ha)	47.02	54.93	78.84	82.02	49.38	67.13	81.97	84.03
4. Diquat dibromide 24.5 SL W/V 918.75 g a.i. ha ⁻¹ (3750 ml/ha)	63.35	72.41	82.59	89.02	60.29	68.97	83.93	87.72
5. Diquat dibromide 24.5 SL W/V 1102.5 g a.i. ha ⁻¹ (4500 ml/ha)	68.35	82.50	93.06	95.16	67.88	82.95	97.08	97.99
6. Paraquat dichloride 24 SL 300 g a.i. ha ⁻¹ (1250 ml/ha)	65.17	76.00	85.45	88.86	59.99	72.99	87.08	89.98
7. Mepiquat chloride 5%AS 62.5 g a.i. ha ⁻¹ (1250 ml/ha)	34.55	36.96	42.50	47.38	32.45	38.98	45.08	55.05
S.E.m ±	2.97	4.37	0.98	0.99	0.76	0.05	0.60	0.15
CD (P=0.5%)	9.16	13.46	3.03	3.06	2.35	0.16	1.85	0.45

Effect on boll opening

Boll opening in cotton was significantly affected due to application of defoliant. Results revealed that application of Diquat dibromide 24.5 SL W/V at 1102.5 g a.i. ha⁻¹ gave significantly the highest boll opening at 5 days after treatments during 2014-15 (Table – 2). Further, the effect of application of Diquat dibromide 24.5 SL W/V at 1102.5 and 918.75 g a.i. ha⁻¹ on boll opening at 10, 15 and 20 days after

treatments was observed at par with the each other but the aforesaid two defoliant gave significantly higher per cent boll opening over rest of the treatments at 10, 15 and 20 days (89.87 and 86.92, 92.94 and 92.40 and 96.17 and 95.04 per cent, respectively) after application.

In the year 2015-16, significantly the maximum per cent boll opening in cotton was noted with application of Diquat dibromide 24.5 SL W/V at 1102.5 g a.i. ha⁻¹ both after 5 and

10 days of treatment application. However, the effect of application of Diquat dibromide 24.5 SL W/V at 1102.5 and 918.75 g a.i. ha⁻¹ in respect of per cent boll opening at 15 and 20 days after treatments was observed at par with each other and the aforesaid two defoliant gave significantly higher per cent boll opening (95.83 – 95.14) over rest of the treatments at 20 days after application. Sarlach *et al.* (2010) [9] and Kumari *et al.* (2013) [7] also observed defoliant to be effective in improving the boll opening percentage to get higher yield potential from the late maturing Bt hybrids without having any adverse effect on fibre quality traits.

Effect on seed cotton yield

Seed cotton yield was influenced significantly with the application of defoliant. Data presented in Table 2 show that application of Diquat dibromide 24.5 SL W/V at 1102.5 g a.i. ha⁻¹ recorded highest seed cotton yield of 27.74 q ha⁻¹ being at par with application of Diquat dibromide 24.5 SL W/V at

918.75 g a.i. ha⁻¹ and Paraquat dichloride at 300 g a.i. ha⁻¹. Application of Diquat dibromide 24.5 SL W/V at 1102.5 g a.i. ha⁻¹ increased the seed cotton yield significantly by 16.40, 14.59, 14.16 and 10.96 per cent over untreated check, Diquat dibromide 24.5 SL W/V at 551 g a.i. ha⁻¹, Diquat dibromide 24.5 SL W/V at 735 g a.i. ha⁻¹ and Mepiquat chloride 5% AS 62.5 g a.i. ha⁻¹ respectively during 2014-15.

In the year 2015-16, application of Diquat dibromide 24.5 SL W/V at 1102.5 g a.i. ha⁻¹ gave highest seed cotton yield of 31.13 q ha⁻¹ and it was found at par with Diquat dibromide 24.5 SL W/V at 918.75 and Paraquat dichloride at 300 g a.i. ha⁻¹. Application of Diquat dibromide 24.5 SL W/V at 1102.5 g a.i. ha⁻¹ recorded significantly higher seed cotton yield by 15.0, 13.72, 11.31 and 6.78 per cent over untreated check, Diquat dibromide 24.5 SL W/V at 551 g a.i. ha⁻¹, Diquat dibromide 24.5 SL W/V at 735 g a.i. ha⁻¹ and Mepiquat chloride 5% AS 62.5 g a.i. ha⁻¹ respectively.

Table 2: Effect of doses of defoliant on boll opening (per cent) and seed cotton yield

Treatments	2014-15					2015-16					2014-15	2015-16
	Before treatment	Days after treatment				Before treatment	Days after treatment				Seed cotton yield (q ha ⁻¹)	
	-	5	10	15	20	-	5	10	15	20		
Untreated check	65.23	71.88	73.95	76.92	81.86	69.15	70.61	75.19	79.91	81.58	23.19	26.46
Diquat dibromide 24.5 SL W/V 551.25 g a.i. ha ⁻¹ (2250 ml/ha)	65.21	72.23	78.56	80.26	83.24	70.12	71.45	78.25	82.46	84.46	23.69	26.86
Diquat dibromide 24.5 SL W/V 735 g a.i. ha ⁻¹ (3000 ml/ha)	65.22	73.82	81.50	84.88	88.59	68.04	73.17	83.65	87.51	88.15	23.81	27.61
Diquat dibromide 24.5 SL W/V 918.75 g a.i. ha ⁻¹ (3750 ml/ha)	65.25	75.33	86.92	92.40	95.04	67.65	76.42	86.52	93.83	95.14	25.44	29.36
Diquat dibromide 24.5 SL W/V 1102.5 g a.i. ha ⁻¹ (4500 ml/ha)	65.60	79.61	89.87	92.94	96.17	70.00	82.57	89.55	95.29	95.83	27.74	31.13
Paraquat dichloride 24 SL 300 g a.i. ha ⁻¹ (1250 ml/ha)	70.65	75.21	78.22	87.85	91.04	69.63	74.94	77.99	89.89	90.55	26.25	30.26
Mepiquat chloride 5% AS 62.5 g a.i. ha ⁻¹ (1250 ml/ha)	66.25	75.57	78.95	85.28	92.18	71.81	75.00	79.46	80.29	82.01	24.70	29.02
S.Em ±	2.79	0.56	1.21	0.59	0.46	2.35	0.57	0.46	0.63	0.38	0.84	0.67
CD (P=0.5%)	NS	1.72	3.72	1.81	1.40	NS	1.75	1.41	1.95	1.17	2.58	2.05

Phytotoxicity studies

Effect on cotton bolls

Data (Table 3) indicate that there was no phytotoxic effects

found with any of the treatments on cotton bolls with increasing days after treatment application during both the years.

Table 3: Phytotoxic effects (per cent)* on cotton bolls

Treatments	2014-15				2015-16			
	Days after treatments				Days after treatments			
	1	3	7	10	1	3	7	10
Untreated check	0	0	0	0	0	0	0	0
Diquat dibromide 24.5 SL W/V 551.25 g a.i. ha ⁻¹ (2250 ml/ha)	0	0	0	0	0	0	0	0
Diquat dibromide 24.5 SL W/V 735 g a.i. ha ⁻¹ (3000 ml/ha)	0	0	0	0	0	0	0	0
Diquat dibromide 24.5 SL W/V 918.75 g a.i. ha ⁻¹ (3750 ml/ha)	0	0	0	0	0	0	0	0
Diquat dibromide 24.5 SL W/V 1102.5 g a.i. ha ⁻¹ (4500 ml/ha)	0	0	0	0	0	0	0	0
Paraquat dichloride 24 SL 300 g a.i. ha ⁻¹ (1250 ml/ha)	0	0	0	0	0	0	0	0
Mepiquat chloride 5% AS 62.5 g a.i. ha ⁻¹ (1250 ml/ha)	0	0	0	0	0	0	0	0

* In respect of chlorosis, necrosis, wilting, scorching, hyponasty and epinasty

Residual effects of Diquat dibromide 24.5 SL W/V on plant population and grain yield and Phytotoxic effects (per cent) on mungbean crop

Results revealed that application of defoliant to cotton crop did not show significantly influence on plant population and grain yield of succeeding mungbean crop. It is evident from data that application of defoliant to cotton crop did not show any phytotoxic effects such as chlorosis, necrosis, wilting, scorching, hyponasty and epinasty on succeeding mungbean crop.

Conclusion

From the results of two years' experimentation, it may be concluded 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 treatment as it gave significantly higher per cent defoliation, per cent boll opening, seed cotton yield with no phytotoxic effects on cotton bolls. The next best treatments were application of Diquat dibromide 24.5 SL W/V at 918.75 g a.i. ha⁻¹ and Paraquat dichloride at 300 g a.i. ha⁻¹.

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