AN AJSS An Asian Journal of Soil Science
Volume 13 | Issue 1 | June, 2018 | 63-69 | e ISSN–0976–7231 ■ Visit us : www.researchjournal.co.in

Research Article

DOI : 10.15740/HAS/AJSS/13.1/63-69

Dry matter production and yield of Bt cotton as influenced by available phosphorus in vertisols

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Received : 07.04.2018; **Revised :** 09.05.2018; **Accepted :** 23.05.2018

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Summary

A field survey was conducted in Bt cotton growing Vertisols of Dharwad district and totally ten villages (Bandiwad, Byahatti, Dattur, Hebsur, Ingalalli, Kiresur, Kusugal, Rottigwada, Siraguppi and Sulla) were selected. From each selected village, five Bt cotton growing farmers were identified and georeferenced soil samples were collected from 0-30 cm depth and analysed for available phosphorus and other parameters using standard procedures. Also quantity of phosphatic fertilizers addition by the farmers to the crop were collected. Dry matter production at both flowering, harvesting and yield obtained were recorded from each selected farmer field by crop cutting experiment. The results of the study indicatethat available phosphorus content varied from 15.5 to 39.50 kg ha^{-1} with an average value of 29.1 kg ha^{-1}. The dry matter yield varied from 142.3 to 186.7 and 302.1 to 347.7 g $plant^{-1}$ at flowering and at harvest, respectively. The highest dry matter production was in soils of Bandiwad and the lowest in soils of Siraguppi. The average yields of Bt cotton in farmer's fields in different villages of Dharwad district varied from 976 to 1092 kg ha^{-1}. The highest and lowest yields were recorded in soils of Bandiwad and Siraguppi, respectively. However, the dry matter production and average yields of Bt cotton in different villages followed the order: Bandiwad > Rottigwad >Kusugal >Hebsur >Dattur >Byahatti > Sulla > Kiresur >Ingalalli>Siraguppi. The soils of Bandiwad village had low P (< 33.50 kg/ha) status thus, they responded well to applied phosphatic fertilizers compared to other villages and resulted in higher dry matter and yield of Bt cotton. Lower dry matter production at both flowering and harvesting and also yield in Siraguppi village may be due to its high available phosphorus status (> 33.50 kg/ha).

Key words : Available phosphorus, Bt cotton, Dry matter, Yield

How to cite this article : Ramya, S.H. and Hebsur, N.S. (2018). Dry matter production and yield of Bt cotton as influenced by available phosphorus in vertisols. *Asian J. Soil Sci.*, **13** (1) : 63-69 : **DOI : 10.15740/HAS/AJSS/13.1/63-69.**

Introduction

Phosphorus is one of the essential macronutrients, which plays an important role in ensuring the growth and development of cotton. It is essential for the vigorous root and shoot growth, promotes early boll development and hastens maturity. Phosphorus overcomes the effects of compaction besides increasing water use efficiency, energy storage and transfer in plants (Anonymous, 2003). Therefore, an adequate supply of phosphorus is indispensable for profitable cotton production. Of the total geographical area, Vertisols occupy about 73 million hectares in India and about 6.9 million hectares in

Karnataka. A large area of Vertisols will continue to be occupied under rainfed condition. Rainfed Vertisols contribute to 60 per cent of total cotton production. Phosphorus is considered a major constraint for cotton production in Vertisols.

The response of crops to P application varies more in Vertisols than in other soils. Kanwar (1986) suggested that the response of crops to applied P diminished in different soil types in the following order: Alfisols > Entisols >Vertisols. Research work carried out at various places indicated that crops do not respond to phosphorus application whenever soil available phosphorus status is more than 33.5 kg P_2O_5 per ha (Sharma and Rajat, 1974 and Khistaria *et al.,* 1980). In the light of above, an investigation was undertaken to understand phosphorus status in some Bt cotton growing Vertisols of Dharwad district in northern Transitional zone of Karnataka to know the response of Bt cotton to applied phosphatic fertilizers during *Kharif* 2012-2013.

Resource and Research Methods

Research work carried out at various places indicated that crops do not respond to phosphorus application whenever soil available phosphorus status is more than 33.5 kg P_2O_5 per ha (Sharma and Rajat, 1974 and Khistaria *et al.,* 1980). In order to test this hypothesis in Bt cotton growing Vertisols, a cluster of villages of Dharwad district *viz.*, Sulla, Byahatti, Kusugal, Hebsur, Ingalalli, Kiresur, Rottigawad, Siraguppi, Bandiwad and Dattur having deep black soils with gentle slope growing Bt cotton as a dominant crop were selected. From each village five farmers were selected and georeferenced soil samples were collected from 0-30 cm depth to estimate the available phosphorus and also other nutrients. Quantity of the phosphatic fertilizers added to the crop by the farmers and also different yield contributing parameters of Bt cotton were recorded.

Research Findings and Discussion

The dry matter yield varied from 142.3 to 186.7 and 302.1 to 347.7 g $plant^{-1}$ at flowering and at harvest, respectively. The highest dry matter production was in soils of Bandiwad and the lowest in soils of Siraguppi. The average dry matter production in soils of different villages followed the order: Bandiwad > Rottigwad > Kusugal > Hebsur > Dattur > Byahatti > Kiresur > Sulla >Ingalalli>Siraguppi (Table 2).

Data presented in the Table 3 represents the uptake of phosphorus by Bt cotton at flowering and harvest and yield of Bt cotton in selected villages of Dharwad district. The uptake of phosphorus by the Bt cotton, in soils of different farmer's fields of Dharwad district ranged from 5.79 to 22.15 and 8.42 to 36.70 kg ha^{-1} at flowering and harvest, respectively. Average uptake of phosphorus by the Bt cotton at flowering and harvest in different villages of Dharwad district was in the order: Bandiwad (15.04 and 24.98) > Rottigwad (14.58 and 23.92) > Kusugal (14.02 and 23.13) > Hebsur (13.32 and 22.67) > Dattur (12.34 and 20.82) > Byahatti (11.92 and 19.54) > Kiresur (11.56 and 19.02) > Sulla (11.02 and 18.02) >Ingalalli (9.18 and 15.10) > Siraguppi (8.98 and 13.68), respectively. Among the ten villages, the highest uptake of phosphorus by Bt cotton was recorded in soils of Bandiwad village (15.04, 24.98 kg/ha) at flowering and harvest, respectively, which could be attributed to good response of Bt cotton to applied phosphatic fertilizer because of low P status (< 33.50 kg P_2O_5/ha) soils of Bandiwad village compared to high P status soils of other villages. Whereas, the lowest P uptake was recorded in soils of Siraguppi village (8.98, 13.68 kg/ha) because of their high initial available P status which has led to poor response of crop to applied phosphatic fertilizers. The uptake of P by cotton in soils of different villages followed their initial P status. The present results are in line with the findings of Puri and Jaipurkar (2000), who inferred that the extent of soil phosphorus uptake by plant had immense relation with the degree of soil P status and concluded that the soil deficit in available P would exhibit increased uptake and consequently increased response and vice versa is true for soils sufficient in phosphorus. Similar observations were also made by Singh and Rana (1979) who stated that greater response of applied P could be expected in low soil P fertility status class and lesser response in high P fertility status soils.

The average yields of Bt cotton in farmer's fields in different villages of Dharwad district varied from 976 to 1092 kg ha^{-1}. The highest and lowest yields were recorded in soils of Bandiwad and Siraguppi, respectively. However, the average yields of Bt cotton in different villages followed the order: Bandiwad > Rottigwad >Kusugal >Hebsur >Dattur >Byahatti > Sulla > Kiresur >Ingalalli>Siraguppi. The variation in yields might be due to the variation in fertility status of soils, management practices and rates of application of fertilizers particularly phosphatic fertilizers. The recommended dose of

Table 1: Initial available phosphorus and quantity of phosphatic fertilizers added by the farmers to Bt cotton in Dharwad district

Sr. No.	Village	Name of the farmer	Initial available P_2O_5 (kg /ha)	Quantity of phosphatic fertilizers added by farmers (kg /ha)
1.	Bandiwad	Ayyappa V. Mulimani	27.5	50
2.		Bharmappa Veerappa Dalagar	30.5	60
3.		Chandrasekhar Madiwalar	18.8	50
4.		Goudappa Patil	28.3	70
5.		Siddaramayya Gurlingayya Hiremath	16.7	55
6.	Byahatti	Basavanagouda Dyamangouda Kallangouda	29.4	45
7.		Hanumanthagouda Sangangouda	27.6	50
8.		Ismail sab	34.3	60
9.		Neelappa Holemannur	15.8	40
10.		Siddanagouda Mottchennappagouda	25.8	55
11.	Dattur	Kallappagudi	35.3	55
12.		Anand Pujar	34.7	50
13.		Yallappagoudar	34.2	65
14.		Shekappa Mulimani	28.1	60
15.		Basavangoudar	34.5	60
16.	Hebsur	Channagouda Shivangouda Patil	33.8	70
17.		Narayanappa Venkappa Mudareddi	30.5	65
18.		Ramappa Bheema Amadlu	32.0	45
19.		Subhash R. Chavaraddi	34.5	55
20.		Thimmaraddi G. Konnur	25.5	65
21.	Ingalalli	Basavaraj Dundur	34.5	50
22.		K.G. Vasthra	34.3	50
23.		Murgappa Hanumanthappa Nategali	36.5	80
24.		Muthappa Talawar	36.6	80
25.		S.P. Dundur	18.5	65
26.	Kiresur	Basappa Y Kamdolli	37.5	70
27.		Govindaraddi T. Bandiwad	20.3	55
28.		M.S. Thirlapur	19.5	50
29.		Somanna Hurali	31.5	65
30.		Veeranna Kamdolli	35.2	55
31.		Basavaraj Parappa Annigeri	33.5	75
32.	Kusugal	Basavaraj Eshwarappa Annigeri	20.6	50
33.		Huchappa Mattigatti	33.7	45
34.		Neelappa Mattigatti	20.0	55
35.		M. V. Kodli	32.1	60
36.	Rottigwad	Ashwini Manjunath Kodli	19.0	55
37.		Basappa D. Bengeri	36.6	60
38.		Basavannappa Fakirappa Kabnur	27.4	60
39.		Ningappa F. Kabnur	29.4	65
40.		Subhash Bengeri	35.3	70
41.	Siraguppi	Ajrasab Gulsab Mishrikoti	39.5	60
42.		Eranna Shekappa Betageri	32.0	55
43.		Gadiyappa Basavannagoudar	35.5	50
44.		Rachappa Mudakappa Angadi	34.0	50
45.		Rudragouda Kantappagoudar	39.5	40
46.	Sulla	Eranna Rudrappa Angadi	34.7	65
47.		B.S. Asundi	18.9	50
48.		G.C Ingalagi	32.0	70
49.		Mahadevappa Chebbi	18.8	60
50.		Veerabhadrappa Asundi	36.2	65

Table 2: Dry matter production at flowering and harvesting of Bt cotton in selected villages of Dharwad district

Sr. No.	Village	Name of the farmer	Dry matter (g/plant)	
			Flowering	Harvest
1.	Bandiwad	Ayyappa V. Mulimani	179.3	348.2
2.		Bharmappa Veerappa Dalagar	186.7	351.2
3.		Chandrasekhar Madiwalar	177.4	345.1
4.		Goudappa Patil	183.9	350.2
5.		Siddaramayya Gurlingayya Hiremath	174.5	343.8
		Average	180.36	347.7
6.	Byahatti	Basavanagouda Dyamangouda Kallangouda	165.4	320.4
7.		Hanumanthagouda Sangangouda	168.9	327.7
8.		Ismail sab	160.6	317.8
9.		Neelappa Holemannur	155.0	310.5
10.		Siddanagouda Mottchennappagouda	157.3	317.7
		Average	161.44	318.8
11.	Dattur	Kallappagudi	163.0	337.6
12.		Anand Pujar	163.4	334.1
13.		Yallappagoudar	164.1	336.9
14.		Shekappa Mulimani	174.0	340.5
15.		Basavangoudar	155.4	332.4
		Average	163.98	336.3
16.	Hebsur	Channagouda Shivangouda Patil	166.6	339.3
17.		Narayanappa Venkappa Mudaraddi	179.4	345.8
18.		Ramappa Bheema Amadlu	163.1	343.8
19.		Subhash R. Chavaraddi	177.4	337.6
20.		Thimmaraddi G. Kunnor	167.1	341.8
		Average	170.72	341.7
21.	Ingalalli	Basavaraj Dundur	152.7	321.6
22.		K.G. Vasthra	154.2	323.8
23.		Murgappa Hanumanthappa Nategali	149.6	318.5
24.		Muthappa Talawar	146.6	322.6
25.		S.P. Dundur	164.2	330.9
		Average	153.46	323.5
26.	Kiresur	Basappa Y Kamdolli	155.3	311.1
27.		Govindaraddi T. Bandiwad	159.7	322.2
28.		M.S. Thirlapur	158.2	320.7
29.		Somanna Hurali	171.3	338.7
30.		Veeranna Kamdolli	151.7	297.9
		Average	159.24	318.1
31.	Kusugal	Basavaraj Parappa Annigeri	173.8	344.6
32.		Basavaraj Eshwarappa Annigeri	166.9	337.8
33.		Huchappa Mattigatti	165.4	335.4
34.		Neelappa Mattigatti	171.5	339.5
35.		M.V. Kodli	183.4	346.5
		Average	172.2	340.8

Table 2 : Contd.……

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36.		Ashwini Manjunath Kadli	177.8	340.2
37.		Basappa .D. Bengeri	168.3	334.3
38.		Basavannappa Fakirappa Kabnur	186.2	345.8
39.		Ningappa F. Kabnur	182.5	344.1
40.		Subhasha Bengeri	170.2	338.6
		Average	177.00	340.6
41.	Siraguppi	Ajirasab Gulsab Mishra Koti	147.8	298.1
42.		Eranna Shekappa Betageri	161.7	311.9
43.		Gadiyappa Basavanagoudar	159.2	309.3
44.		Rachappa Mudakappa Angadi	142.3	295.6
45.		Rudragoudar Kantappagoudar	142.7	295.4
		Average	150.74	302.1
46.	Sulla	Eranna Rudrappa Angadi	148.6	311.1
47.		B.S. Asundi	168.5	328.5
48.		G.C Ingalagi	171.2	332.6
49.		Mahadevappa Chebbi	155.3	320.8
50.		Veerabadrappa Asundi	143.7	306.6
		Average	157.46	319.9

phosphatic fertilizer to Bt cotton under rainfed condition is 60 kg P_2O_5 ha^{-1} but the phosphorus fertilizer applied by the farmer's of Dharwad district to Bt cotton ranged from 45 to 80 kg P_2O_5 ha^{-1}. In general, the soils low in available P status (<33.50 kg/ha) responded well to the higher rates of P fertilizer and soils with high P status had poor response. This clearly demonstrates that the response of Bt cotton to applied phosphatic fertilizer depends upon available P_2O_5 content in the soils. The soils of Bandiwad village had low P (< 33.50 kg/ha) status thus they responded well to applied phosphatic fertilizers as evident from higher uptake of P (15.04 and 24.96 kg/ha)at flowering and harvesting, respectively. Increase in uptake of phosphorus by plant led to better growth, dry matter production and ultimately higher yield. Similar observations were also made by Nehra and Yadav (2011) who stated that all the yield attributing characters increased significantly with increase in levels of applied P_2O_5 from 20 to 60 kg/ha P_2O_5) in the soil having available P in medium range. Singh and Mannikar (2000) and Srinivasulu *et al.* (2007) reported that recommended NPK (120:60:60 kg/ha) was found to be optimum for achieving higher seed yield of hybrid Bt cotton in black cotton soils having low available P status (28.8 kg P_2O_5/ha) under rainfed condition. According to Solankey *et al.* (1994) application of 60 kg P_2O_5 per ha^{-1} was found to be optimum for JKH-1 in swell-shrink soils of Madhya Pradesh under rainfed situation. In soils having high available P (> 33.5 kg/ha) cotton crop did not respond well to applied fertilizers resulting in lower uptake of nutrients by plant ultimately leading to low yields. Sharma and Rajat (1974) reported response of wheat to the application of P upto 80 kg P_2O_5 ha^{-1} in a soil with low P (17.0 kg/ha) in respect of dry matter and grain yield during the first year of experimentation. But, they noticed response of crop upto 40 kg P_2O_5 ha^{-1} when the soil P_2O_5 status was more than 33.50 kg ha^{-1}. Khistaria *et al.* (1980) indicated that application of graded levels of phosphorus *viz.*, 22, 45 and 68 kg P_2O_5 having available P_2O_5 of about 34.50 kg ha^{-1} had shown no significant effect on yield. This lack of response to applied phosphorus was due to the ability of soil to meet the requirement of crop. Malik *et al.* (1992) also observed no response of cotton to the application of graded levels of P_2O_5 from 0 to 100 kg ha^{-1} in soils with more than 33.5 kg P_2O_5 ha^{-1}.

Conclusion:

The response of Bt cotton to applied phosphatic fertilizer was poor in Vertisols having P_2O_5 status more than 33.50 kg ha^{-1}. However, a good response to applied fertilizers interms of higher dry matter production in both flowering and harvesting and yield was observed in low P status soils (< 33.50 kg P_2O_5/ha).

Table 3: Uptake of phosphorus by Bt cotton at flowering and harvest and yield of Bt cotton in selected villages of Dharwad district

Sr. No.	Village	Name of the farmer	Uptake (kg/ha)		Yield (kg/ha)
			Flowering	Harvest	
1.	Bandiwad	Ayyappa V. Mulimani	15.09	24.85	1090
2.		Bharmappa Veerappa Dalagar	18.79	31.49	1180
3.		Chandrasekhar Madiwalar	18.79	31.49	1000
4.		Goudappa Patil	17.50	29.48	1160
5.		Siddaramayya Gurlingayya Hiremath	12.66	18.25	1030
		Average	15.04	24.98	1092
6.	Byahatti	Basavanagouda Dyamangouda Kallangouda	13.02	22.28	1053
7.		Hanumanthagouda Sangangouda	15.15	25.19	1090
8.		Ismail sab	10.87	16.86	1010
9.		Neelappa Holemannur	9.93	14.78	1000
10.		Siddanagouda Mottchennappagouda	10.65	18.60	1010
		Average	11.92	19.54	1032
11.	Dattur	Kallappagudi	11.93	19.77	1025
12.		Anand Pujar	11.36	18.96	1020
13.		Yallappagoudar	11.71	20.35	1025
14.		Shekappa Mulimani	15.92	26.80	1110
15.		Basavangoudar	10.81	18.25	1018
		Average	12.34	20.82	1039
16.	Hebsur	Channagouda Shivangouda Patil	12.20	20.49	1032
17.		Narayanappa Venkappa Mudaraddi	18.38	31.01	1180
18.		Ramappa Bheema Amadlu	13.13	23.91	1080
19.		Subhash R. Chavaraddi	10.06	15.44	1010
20.		Thimmaraddi G. Kunnor	12.84	22.52	1050
		Average	13.32	22.67	1070
21.	Ingalalli	Basavaraj Dundur	7.62	12.36	997
22.		K.G. Vasthra	8.10	13.04	1006
23.		Murgappa Hanumanthappa Nategali	7.39	11.66	985
24.		Muthappa Talawar	7.78	12.40	969
25.		S.P. Dundur	15.02	26.04	1100
		Average	9.18	15.10	1011
26.	Kiresur	Basappa Y Kamdolli	9.09	14.23	990
27.		Govindaraddi T. Bandiwad	13.44	22.41	1030
28.		M.S. Thirlapur	11.00	18.19	1020
29.		Somanna Hurali	18.18	30.99	1180
30.		Veeranna Kamdolli	6.11	9.27	920
		Average	11.56	19.02	1028
31.	Kusugal	Basavaraj Parappa Annigeri	13.36	22.07	1045
32.		Basavraj Eshwarappa Annigeri	11.91	19.17	1023
33.		Huchappa Mattigatti	11.50	18.41	1020
34.		Neelappa Mattigatti	12.87	20.50	1027
35.		M.V. Kodli	20.47	35.51	1250
		Average	14.02	23.13	1073

Table 3: Contd……..

Table 3: Contd……

36.	Rottigwad	Ashwini Manjunath Kadli	13.67	23.04	1040
37.		Basappa D. Bengeri	7.70	12.24	950
38.		Basavannappa Fakirappa Kabnur	22.15	36.70	1230
39.		Ningappa F. Kabnur	20.04	32.75	1200
40.		Subhasha Bengeri	9.34	14.87	960
		Average	14.58	23.92	1076
41.	Siraguppi	Ajirasab Gulsab Mishrakoti	7.57	12.55	960
42.		Eranna Shekappa Betageri	13.61	21.69	1000
43.		Gadiyappa Basavanagoudar	9.91	14.15	990
44.		Rachappa Mudakappa Angadi	6.51	9.20	959
45.		Rudragoudar Kantappagoudar	7.31	10.81	957
		Average	8.98	13.68	976
46.	Sulla	Eranna Rudrappa Angadi	6.25	9.68	940
47.		B.S. Asundi	16.29	25.24	1110
48.		G.C Ingalagi	15.42	26.78	1130
49.		Mahadevappa Chebbi	11.37	19.96	1020
50.		Veerabadrappa Asundi	5.79	8.42	914
		Average	11.02	18.02	1022

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