Journal of Applied and Natural Science 9 (4): 2315 - 2326 (2017)

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Nutrient uptake and soil fertility status after harvest of Bt cotton as influenced by graded levels of NPK fertilizers in Alfisol

T. V. Jyothi* and N. S. Hebsur

Department of Soil Science and Agricultural Chemistry, UAS, Dharwad- 580005 (Karnataka), INDIA
*Corresponding author: E-mail: veeranna.jyothi@gmail.com

Received: March 11, 2017; Revised received: June 14, 2017; Accepted: October 25, 2017

Abstract: Field studies were conducted at farmer's fields in Jodalli (Kalghatgi taluk) and Pale (Hubballi taluk) villages in 2012-13 and 2013-14, respectively to investigate the effect of NPK fertilizers on uptake of nutrients by Bt cotton and soil fertility status at harvest in Alfisol. Among the different treatment combinations, the application of 150:50:75 kg $N:P_2O_5:K_2O$ ha^{-1} ($N_3P_1K_2$) recorded significantly (P=0.05) higher nitrogen (132.63 kg ha^{-1}), phosphorus (31.26 kg ha^{-1}) and potassium (128.94 kg ha^{-1}) uptake by cotton. The interaction effect with respect to total micronutrients (Zn, Fe, Mn and Cu) uptake remained non significant at all the growth stages. Graded levels of fertilizers failed to exert significant impact on pH and electrical conductivity, soil organic carbon and available micronutrients during both the years of experimentation. The application of 100:50:50 kg $N:P_2O_5:K_2O$ ha^{-1} ($N_1P_1K_1$) recorded significantly (P=0.05) highest available nitrogen (150.39 kg ha^{-1}), available phosphorus (37.98 kg ha^{-1}) and available potassium (230.99 kg ha^{-1}) compared to rest of the treatments. The lowest available nitrogen (134.92 kg ha^{-1}), available phosphorus (31.65 kg ha^{-1}) and available potassium (217.63 kg h a^{-1}) were recorded in treatment receiving 150:50:75 kg $N:P_2O_5:K_2O$ ha^{-1} ($N_3P_1K_2$).

Keywords: Alfisol, Cotton, Fertility, Fertilizers, Nutrient uptake

INTRODUCTION

Cotton (*Gossypium species*) enjoys a pre-eminent status among all the commercial crops in the country, being the principal raw material for flourishing textile industry. In India, in spite of several competitions from synthetic fibers in recent years, it is occupying a premiere position with 70 per cent share in the textile industry (Waiker *et al.*, 2015). The nutrient management in cotton is a complex phenomenon due to its long duration and indeterminate growth habit where simultaneous production of vegetative and reproductive structures during the active growth phase takes place. Cotton plant being a heavy feeder, needs proper supply of plant nutrients for its successive cultivation (Tayade and Dhoble, 2010). Cotton removes good amounts of plant nutrients from the soil. The choice of appropriate nutrient management and crop rotation determines the efficiency of nutrients. Nutrient uptake by cotton is driven by the demand for nutrients from the developing crop, which is regulated by the supply of nutrients from the soil. Nutrients are taken up throughout the growing season and in proportion with the demand for nutrients as dictated by the developing crop biomass and boll load. The rates of nutrient uptake increase at flowering through fruiting, and then slow as the bolls mature (Mullins and Burmester, 2010).

Cotton has high demand for nutrients such as N and K in excess of 200 kg ha^{-1} and daily accumulation rates of up to 4 kg $ha^{-1}day^{-1}$, whereas trace nutrient needs are more easily met (up to 1 kg ha^{-1}) with fertilizer application where appropriate. Understandably, N has been more thoroughly studied than other nutrients, as N is most commonly deficient in agricultural systems without fertilizer addition. Redistribution of nutrients from vegetative to reproductive plant parts is a vital component of cotton plant nutrition, particularly for nitrogen and phosphorus (Rochester *et al.*, 2012). In this direction, a detailed research was taken up with an objective of studying the effect of NPK fertilizers on nutrient uptake by Bt cotton and soil fertility status after harvest of cotton in Alfisol.

MATERIALS AND METHODS

Using factorial randomized complete block design with three replications and nineteen treatments we conducted two year field experiments in farmer's field one at Jodalli village (Kalghatgi taluk) in 2012-13 situated at $15^0$19'865" North latitude and $75^0$00'65" East longitude and another at Pale village (Hubballi taluk) in 2013-14 situated at $15^0$14'404" North latitude and $75^0$08'600" East longitude under protective irrigated condition with an aim to evaluate the effect of NPK levels on uptake of nutrients by Bt cotton and soil fertility status after harvest of the crop in Alfisol. The farmer of Jodalli village did not agree to take up the experiment during second year. Hence, the experiment was conducted at Pale. Composite soil samples were

ISSN : 0974-9411 (Print), 2231-5209 (Online)

drawn from each experimental site before sowing and were analyzed for physico-chemical properties by following standard analytical procedures. The soil of experimental site was sandy loam in texture with acidic pH (6.27) and non-saline. The fertility status of the soil was low and medium in the available N, P_2O_5, and K_2O and the values were 131.40 kg ha^{-1}, 28.60 kg ha^{-1} and 208.90 kg ha^{-1}, respectively. The spacing adopted was 90 cm and between rows and 60 cm between plants for hybrid cotton. The treatment details are given below.

Treatment details

A. Factor - I (N levels)

N_1 : 100 kg ha^{-1}, N_2 : 125 kg ha^{-1}, N_3 : 150 kg ha^{-1}

B. Factor - II (P_2O_5 levels)

P_1 : 50 kg ha^{-1}, P_2 : 75 kg ha^{-1}

C. Factor - III (K_2O levels)

K_1 : 50 kg ha^{-1}, K_2 : 75 kg ha^{-1}, K_3 : 100 kg ha^{-1}

Absolute control: Gap filling was done after seven days of sowing to avoid patchy crop stand. To maintain desired plant density, thinning was done at about 20 days after sowing (DAS). Entire recommended dose of phosphorus and potassium and 50 per cent of nitrogen were applied after germination by ring method. Remaining 50 per cent of nitrogen was applied at 60 DAS as per the package of practice, UAS, Dharwad. Adequate plant protection measures were taken as per the recommended package for Bt cotton as and when required at various growth stages commonly to all the treatments.

Treatment wise plant samples were collected at 60, 90, 120 DAS and harvest by uprooting the entire plant carefully. At 120 DAS and harvest stage, the cotton was picked separately and then the plant was uprooted. The plant samples were first washed with distilled water and dried in shade and then oven dried at 60 ^oC to get constant weight. Then, the plant samples were powdered in a grinder and stored in butter paper bags. Plant samples were digested with diacid mixture (nitric acid and perchloric acid in 9:4 ratio), after pre-digesting with concentrated nitric acid until clear and white residue was obtained. Then, the residue was dissolved in 6 N HCl and finally volume was made up to 100 ml using distilled water (Tandon, 1998).

Total nitrogen was determined by micro Kjeldahl's method using digestion mixture consisting of K_2SO_4, $CuSO_4$ and selenium powder in presence of H_2SO_4. Half a gram of plant sample was digested in a block digestion unit. After complete digestion, the samples were distilled using micro Kjeldahl unit and the liberated ammonia was trapped in boric acid containing mixed indicator and titrated against 0.01 N H_2SO_4 (Tandon, 1998). The phosphorus in the plant digest was determined by vanadomolybdate yellow colour method in nitric acid medium. The intensity of colour was read at 420 nm wavelength using spectrophotometer (Tandon, 1998). Potassium in the plant digest was estimated by automizing the diluted plant extract in the flame photometer (Tandon, 1998). Micronutrients in the plant digest were estimated by atomic absorption spectrophotometer (Tandon, 1998).

The soil pH was measured in 1:2.5 soil water suspension using pH meter and EC (dS m^{-1}) was measured in the supernatant solution of 1:2.5 soil water extract using conductivity bridge (Sparks, 1996). Organic carbon was estimated by Walkley and Black's wet oxidation method (Sparks, 1996). Available nitrogen was estimated by modified alkaline $KMnO_4$ method (Sharawat and Burford, 1982). Available phosphorus was extracted with Olsen's and Bray's reagent depending on their pH and the amount of P in the extract was estimated by chlorostannous reduced phosphomolybdate blue colour method using spectrophotometer at wavelength of 660 nm (Sparks, 1996). Available potassium was extracted with neutral normal ammonium acetate extract and determined by using flame photometer as described by Sparks (1996). The micronutrients were extracted with DTPA extractant and the aliquot was assessed by using Atomic Absorption Spectrophotometer (Lindsay and Norvell, 1978).

RESULTS AND DISCUSSION

Effect of NPK fertilizers on nutrient uptake by Bt cotton in Alfisols: The uptake of NPK nutrients increased significantly (P=0.05) with increase in levels of nitrogen, phosphorus and potassium at all the growth stages except at 60 DAS. Among the different treatment combinations, the application of 150:50:75 kg $N:P_2O_5:K_2O$ ha^{-1} ($N_3P_1K_2$) recorded significantly (P=0.05) the highest uptake of nitrogen (132.63 kg ha^{-1}), phosphorus (31.26 kg ha^{-1}) and potassium (128.94 kg ha^{-1}) over rest of the treatments at harvest. However, the treatment $N_3P_1K_3$ (150:50:100 kg $N:P_2O_5:K_2O$ ha^{-1}) was on par with $N_3P_1K_2$ at all the growth stages (Table 1 to 6). The interaction effect with respect to total micronutrients (Zn, Fe, Mn and Cu) uptake remained non significant at all the growth stages. However, the treatment receiving 150:50:75 kg $N:P_2O_5:K_2O$ ha^{-1} ($N_3P_1K_2$) recorded higher total micronutrients (Zn, Fe, Mn and Cu) uptake at all the growth stages. The higher uptake could be attributed to the highest yield observed in the treatment. Normally uptake follows the dry matter yield and yield of crops. In a study conducted by Zakaria *et al.* (2009) also obtained similar findings in which N @ 142.8 kg N ha^{-1} and K_2O @ 1.15 kg ha^{-1} recorded 1560.8 mg $plant^{-1}$ and 1615 mg $plant^{-1}$, respectively as compared to rest of the treatments in Egyptian cotton. A synergism in the uptake of N, P and K occurs as K is the main counter ion for root nitrate uptake and xylem transport to shoots (Marschner, 1995), *i.e.* increasing N and P uptake rates require increasing uptake of K for balancing charges (Peuke *et al.*, 2002). These findings reveal the fact that N is an essential nutrient in building the plant dry matter as well as many energy-rich com-

Table 1: Nitrogen uptake by Bt cotton as influenced by different levels of NPK at 60 and 90 DAS in Alfisol.

Treatments	Nitrogen uptake (kg ha^{-1})					
	60 DAS			90 DAS		
	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled
N_1	25.09	26.40	25.74	65.57	67.29	66.43
N_2	27.40	28.71	28.05	71.73	73.29	72.51
N_3	28.72	30.22	29.47	76.76	79.25	78.00
S.Em.±	**0.25**	**0.31**	**0.19**	**0.42**	**0.37**	**0.27**
C.D. at 5%	**0.71**	**0.91**	**0.56**	**1.21**	**1.07**	**0.77**
P_1	26.79	28.44	27.61	70.76	72.94	71.85
P_2	27.35	28.44	27.89	71.94	73.62	72.78
S.Em.±	**0.20**	**0.26**	**0.16**	**0.34**	**0.30**	**0.22**
C.D. at 5%	**NS**	**NS**	**NS**	**0.99**	**NS**	**0.63**
K_1	26.66	27.75	27.21	70.39	71.78	71.09
K_2	27.16	28.40	27.78	71.60	73.69	72.64
K_3	27.38	29.18	28.28	72.07	74.37	73.22
S.Em.±	**0.25**	**0.31**	**0.19**	**0.42**	**0.37**	**0.27**
C.D. at 5%	**NS**	**0.91**	**0.56**	**1.21**	**1.07**	**0.77**
N_1P_1	24.47	25.83	25.15	65.11	67.24	66.17
N_1P_2	25.70	26.97	26.33	66.03	67.35	66.69
N_2P_1	26.07	27.78	26.92	69.68	71.57	70.63
N_2P_2	28.74	29.63	29.19	73.78	75.01	74.40
N_3P_1	29.84	31.71	30.77	77.49	80.01	78.75
N_3P_2	27.60	28.73	28.16	76.02	78.49	77.26
S.Em.±	**0.35**	**0.45**	**0.27**	**0.59**	**0.53**	**0.38**
C.D. at 5%	**1.00**	**1.28**	**0.79**	**1.71**	**1.52**	**1.09**
N_1K_1	24.13	25.27	24.70	64.25	65.14	64.69
N_1K_2	25.09	26.09	25.59	65.61	67.15	66.38
N_1K_3	26.03	27.84	26.93	66.85	69.59	68.22
N_2K_1	26.80	27.76	27.28	70.10	71.08	70.59
N_2K_2	27.17	28.38	27.78	72.01	73.54	72.78
N_2K_3	28.23	29.98	29.11	73.08	75.25	74.17
N_3K_1	29.06	30.21	29.63	76.83	79.13	77.98
N_3K_2	29.21	30.73	29.97	77.17	80.36	78.77
N_3K_3	27.88	29.71	28.79	76.27	78.26	77.27
S.Em.±	**0.43**	**0.55**	**0.34**	**0.73**	**0.65**	**0.46**
C.D. at 5%	**1.23**	**1.57**	**0.97**	**NS**	**1.86**	**1.34**
P_1K_1	26.20	27.50	26.85	69.93	71.50	70.71
P_1K_2	26.88	28.74	27.81	71.26	73.53	72.39
P_1K_3	27.29	29.08	28.19	71.10	73.79	72.45
P_2K_1	27.13	28.00	27.57	70.86	72.07	71.46
P_2K_2	27.44	28.06	27.75	71.94	73.84	72.89
P_2K_3	27.47	29.27	28.37	73.03	74.95	73.99
S.Em.±	**0.35**	**0.45**	**0.27**	**0.59**	**0.53**	**0.38**
C.D. at 5%	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**
$N_1P_1K_1$	23.35	25.05	24.20	63.96	64.92	64.44
$N_1P_1K_2$	24.33	25.77	25.05	65.21	67.03	66.12
$N_1P_1K_3$	25.74	26.67	26.20	66.16	69.77	67.96
$N_1P_2K_1$	24.92	25.49	25.21	64.53	65.36	64.95
$N_1P_2K_2$	25.85	26.40	26.13	66.01	67.27	66.64
$N_1P_2K_3$	26.33	29.01	27.67	67.54	69.42	68.48
$N_2P_1K_1$	25.39	26.64	26.02	69.02	70.42	69.72
$N_2P_1K_2$	25.67	27.21	26.44	69.84	71.57	70.71
$N_2P_1K_3$	27.13	29.48	28.31	70.19	72.72	71.46
$N_2P_2K_1$	28.22	28.87	28.55	71.18	71.74	71.46
$N_2P_2K_2$	28.67	29.55	29.11	74.19	75.52	74.85
$N_2P_2K_3$	29.33	30.48	29.90	75.98	77.77	76.87
$N_3P_1K_1$	29.85	30.79	30.32	76.80	79.16	77.98
$N_3P_1K_2$	30.64	33.25	31.94	78.72	81.99	80.36
$N_3P_1K_3$	29.01	31.09	30.05	76.95	78.88	77.92
$N_3P_2K_1$	28.26	29.63	28.95	76.85	79.10	77.98
$N_3P_2K_2$	27.78	28.22	28.00	75.63	78.73	77.18
$N_3P_2K_3$	26.75	28.33	27.54	75.59	77.64	76.61
S.Em.±	**0.60**	**0.77**	**0.48**	**1.03**	**0.91**	**0.66**
C.D. at 5%	**NS**	**NS**	**NS**	**2.96**	**2.63**	**1.89**
Control	19.72	21.59	20.66	55.58	60.56	58.07
S.Em.±	**0.65**	**0.76**	**0.48**	**1.06**	**0.95**	**0.66**
C.D. at 5%	**1.87**	**2.17**	**1.37**	**3.04**	**2.73**	**1.88**

FYM – 5 t ha^{-1};N_1 – 100 kg ha^{-1}; N_2 – 125 kg ha^{-1} ; N_3- 150 kg ha^{-1} ; P_1 – 50 kg ha^{-1} ; P_2 – 75 kg ha^{-1} ; K_1 – 50 kg ha^{-1}; K_2 – 75 kg ha^{-1} ; K_3 - 100 kg ha^{-1} ; NS – Non significant ; DAS – Days after sowing

Table 2. Nitrogen uptake by Bt cotton as influenced by different levels of NPK at 120 DAS and harvest in Alfisol.

Treatments	Nitrogen uptake (kg ha^{-1})					
	120 DAS			At harvest		
	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled
N_1	117.98	119.76	118.87	119.43	121.11	120.27
N_2	121.22	124.00	122.61	123.88	125.25	124.56
N_3	126.33	130.16	128.25	128.59	130.07	129.33
S.Em.±	0.51	0.40	0.30	0.44	0.39	0.32
C.D. at 5%	1.47	1.14	0.88	1.26	1.11	0.91
P_1	121.52	123.77	122.65	123.87	125.27	124.57
P_2	122.16	125.51	123.84	124.06	125.69	124.88
S.Em.±	0.42	0.32	0.25	0.36	0.32	0.26
C.D. at 5%	NS	0.93	0.72	NS	NS	NS
K_1	120.73	123.29	122.01	122.46	123.68	123.07
K_2	122.29	125.07	123.68	124.07	125.88	124.98
K_3	122.51	125.56	124.03	125.37	126.88	126.12
S.Em.±	0.51	0.40	0.30	0.44	0.39	0.32
C.D. at 5%	1.47	1.14	0.88	1.26	1.11	0.91
N_1P_1	117.36	119.23	118.30	118.91	120.77	119.84
N_1P_2	118.59	120.29	119.44	119.95	121.46	120.70
N_2P_1	119.08	120.74	119.91	122.16	123.48	122.82
N_2P_2	123.37	127.27	125.32	125.59	127.03	126.31
N_3P_1	128.13	131.36	129.74	130.53	131.56	131.04
N_3P_2	124.53	128.97	126.75	126.65	128.59	127.62
S.Em.±	0.72	0.56	0.43	0.62	0.55	0.45
C.D. at 5%	2.08	1.61	1.24	1.78	1.57	1.29
N_1K_1	116.55	117.96	117.26	118.36	119.33	118.85
N_1K_2	118.14	119.81	118.98	119.38	121.20	120.29
N_1K_3	119.24	121.51	120.37	120.54	122.81	121.67
N_2K_1	119.38	121.86	120.62	120.63	121.88	121.25
N_2K_2	121.36	124.37	122.86	123.57	125.37	124.47
N_2K_3	122.92	125.78	124.35	127.43	128.51	127.97
N_3K_1	126.26	130.06	128.16	128.38	129.82	129.10
N_3K_2	127.37	131.03	129.20	129.25	131.08	130.16
N_3K_3	125.36	129.39	127.37	128.13	129.32	128.72
S.Em.±	0.88	0.69	0.53	0.76	0.67	0.55
C.D. at 5%	NS	1.97	1.52	2.18	1.93	1.58
P_1K_1	120.20	122.11	121.15	122.38	123.35	122.86
P_1K_2	122.08	124.50	123.29	124.40	126.22	125.31
P_1K_3	122.30	124.72	123.51	124.82	126.24	125.53
P_2K_1	121.27	124.48	122.87	122.54	124.01	123.27
P_2K_2	122.50	125.64	124.07	123.74	125.55	124.64
P_2K_3	122.72	126.40	124.56	125.91	127.51	126.71
S.Em.±	0.72	0.56	0.43	0.62	0.55	0.45
C.D. at 5%	NS	NS	NS	NS	NS	NS
$N_1P_1K_1$	115.77	117.17	116.47	117.75	119.48	118.61
$N_1P_1K_2$	117.74	119.20	118.47	118.94	120.55	119.74
$N_1P_1K_3$	118.58	121.32	119.95	120.05	122.28	121.16
$N_1P_2K_1$	117.34	118.75	118.04	118.98	119.19	119.08
$N_1P_2K_2$	118.53	120.42	119.48	119.83	121.85	120.84
$N_1P_2K_3$	119.90	121.69	120.79	121.04	123.33	122.18
$N_2P_1K_1$	117.39	118.77	118.08	119.67	120.12	119.90
$N_2P_1K_2$	119.09	121.43	120.26	122.55	124.56	123.55
$N_2P_1K_3$	120.75	122.01	121.38	124.28	125.76	125.02
$N_2P_2K_1$	121.37	124.94	123.15	121.59	123.64	122.61
$N_2P_2K_2$	123.63	127.30	125.47	124.60	126.18	125.39
$N_2P_2K_3$	125.10	129.55	127.33	130.59	131.26	130.92
$N_3P_1K_1$	127.42	130.38	128.90	129.73	130.44	130.08
$N_3P_1K_2$	129.40	132.86	131.13	131.72	133.55	132.63
$N_3P_1K_3$	127.56	130.82	129.19	130.15	130.69	130.42
$N_3P_2K_1$	125.11	129.74	127.43	127.04	129.20	128.12
$N_3P_2K_2$	125.34	129.21	127.27	126.79	128.61	127.70
$N_3P_2K_3$	123.15	127.96	125.56	126.11	127.95	127.03
S.Em.±	1.25	0.97	0.75	1.07	0.95	0.78
C.D. at 5%	3.60	2.79	2.15	3.08	2.73	2.24
Control	110.93	113.88	112.41	113.30	115.72	114.51
S.Em.±	1.37	1.27	0.78	1.05	1.02	0.78
C.D. at 5%	3.94	3.63	2.22	3.00	2.93	2.24

Note: FYM – 5 t ha^{-1};N_1 – 100 kg ha^{-1}; N_2 – 125 kg ha^{-1} ; N_3- 150 kg ha^{-1} ; P_1 – 50 kg ha^{-1} ; P_2 – 75 kg ha^{-1} ; K_1 – 50 kg ha^{-1}; K_2 – 75 kg ha^{-1} ; K_3 - 100 kg ha^{-1} ; NS – Non significant ; DAS – Days after sowing

Table 3. Phosphorus uptake by Bt cotton as influenced by different levels of NPK at 60 and 90 DAS in Alfisol.

Treatments	Phosphorus uptake (kg ha^{-1})					
	60 DAS			90 DAS		
	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled
N_1	5.36	5.77	5.57	12.36	14.73	13.55
N_2	5.46	6.01	5.74	15.81	16.86	16.34
N_3	5.53	5.93	5.73	17.23	19.19	18.21
S.Em.±	0.02	0.05	0.03	0.20	0.27	0.19
C.D. at 5%	0.05	0.14	0.08	0.56	0.78	0.55
P_1	5.46	5.93	5.69	14.91	16.79	15.85
P_2	5.45	5.87	5.66	15.37	17.07	16.22
S.Em.±	0.01	0.04	0.02	0.16	0.22	0.16
C.D. at 5%	NS	NS	NS	NS	NS	NS
K_1	5.41	5.82	5.61	14.42	16.46	15.44
K_2	5.46	5.93	5.70	15.40	17.09	16.24
K_3	5.49	5.96	5.72	15.59	17.23	16.41
S.Em.±	0.02	0.05	0.03	0.20	0.27	0.19
C.D. at 5%	0.05	NS	0.08	0.56	NS	0.55
N_1P_1	5.35	5.73	5.54	11.53	14.06	12.79
N_1P_2	5.37	5.81	5.59	13.20	15.41	14.30
N_2P_1	5.42	5.97	5.70	15.45	16.00	15.72
N_2P_2	5.50	6.05	5.78	16.18	17.72	16.95
N_3P_1	5.59	6.09	5.84	17.75	20.31	19.03
N_3P_2	5.47	5.77	5.62	16.72	18.07	17.39
S.Em.±	0.02	0.07	0.04	0.28	0.38	0.27
C.D. at 5%	0.07	0.20	0.11	0.80	1.10	0.78
N_1K_1	5.31	5.53	5.42	11.27	13.83	12.55
N_1K_2	5.36	5.82	5.59	12.56	15.24	13.90
N_1K_3	5.42	5.96	5.69	13.27	15.13	14.20
N_2K_1	5.36	5.95	5.65	15.14	16.17	15.65
N_2K_2	5.48	6.02	5.75	15.68	16.23	15.96
N_2K_3	5.55	6.06	5.81	16.62	18.18	17.40
N_3K_1	5.55	5.97	5.76	16.86	19.39	18.13
N_3K_2	5.54	5.96	5.75	17.95	19.79	18.87
N_3K_3	5.50	5.85	5.68	16.90	18.39	17.64
S.Em.±	0.03	0.09	0.05	0.34	0.47	0.33
C.D. at 5%	0.09	NS	0.14	0.98	1.35	0.95
P_1K_1	5.39	5.83	5.61	13.86	16.03	14.94
P_1K_2	5.47	5.95	5.71	15.51	17.49	16.50
P_1K_3	5.51	6.00	5.75	15.36	16.85	16.10
P_2K_1	5.42	5.80	5.61	14.98	16.90	15.94
P_2K_2	5.45	5.91	5.68	15.28	16.68	15.98
P_2K_3	5.47	5.91	5.69	15.83	17.62	16.73
S.Em.±	0.02	0.07	0.04	0.28	0.38	0.27
C.D. at 5%	NS	NS	NS	NS	NS	0.78
$N_1P_1K_1$	5.27	5.50	5.39	9.85	12.87	11.36
$N_1P_1K_2$	5.35	5.74	5.54	11.98	14.54	13.26
$N_1P_1K_3$	5.43	5.95	5.69	12.75	14.78	13.76
$N_1P_2K_1$	5.35	5.56	5.45	12.68	14.79	13.74
$N_1P_2K_2$	5.38	5.90	5.64	13.14	15.95	14.54
$N_1P_2K_3$	5.40	5.97	5.68	13.78	15.49	14.64
$N_2P_1K_1$	5.30	5.92	5.61	14.93	15.72	15.33
$N_2P_1K_2$	5.44	5.97	5.71	15.45	16.06	15.76
$N_2P_1K_3$	5.53	6.03	5.78	15.97	16.21	16.09
$N_2P_2K_1$	5.42	5.97	5.70	15.34	16.62	15.98
$N_2P_2K_2$	5.52	6.08	5.80	15.92	16.40	16.16
$N_2P_2K_3$	5.57	6.10	5.83	17.27	20.15	18.71
$N_3P_1K_1$	5.60	6.09	5.84	16.79	19.50	18.15
$N_3P_1K_2$	5.63	6.16	5.89	19.11	21.88	20.49
$N_3P_1K_3$	5.55	6.03	5.79	17.36	19.55	18.45
$N_3P_2K_1$	5.50	5.85	5.68	16.93	19.28	18.10
$N_3P_2K_2$	5.45	5.77	5.61	16.79	17.69	17.24
$N_3P_2K_3$	5.45	5.68	5.56	16.44	17.24	16.84
S.Em.±	0.04	0.12	0.07	0.48	0.66	0.47
C.D. at 5%	NS	NS	NS	1.38	1.90	1.34
Control	5.08	5.15	5.12	5.96	7.67	6.82
S.Em.±	0.04	0.12	0.07	0.48	0.65	0.46
C.D. at 5%	0.12	0.34	0.19	1.38	1.86	1.32

Note: FYM – 5 t ha^{-1};N_1 – 100 kg ha^{-1}; N_2 – 125 kg ha^{-1} ; N_3- 150 kg ha^{-1} ; P_1 – 50 kg ha^{-1} ; P_2 – 75 kg ha^{-1} ; K_1 – 50 kg ha^{-1}; K_2 – 75 kg ha^{-1} ; K_3 - 100 kg ha^{-1} ; NS – Non significant ; DAS – Days after sowing.

Table 4. Phosphorus uptake by Bt cotton as influenced by different levels of NPK at 120 DAS and harvest in Alfisol.

Treatments	Phosphorus uptake (kg ha^{-1})					
	120 DAS			At harvest		
	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled
N_1	19.82	20.98	20.40	21.19	22.79	21.99
N_2	23.26	24.12	23.69	24.57	26.59	25.58
N_3	25.14	27.36	26.25	27.87	30.26	29.07
S.Em.±	0.52	0.45	0.38	0.32	0.26	0.20
C.D. at 5%	1.50	1.29	1.08	0.92	0.74	0.59
P_1	22.43	23.91	23.17	24.42	26.23	25.32
P_2	23.06	24.40	23.73	24.67	26.86	25.76
S.Em.±	0.43	0.37	0.31	0.26	0.21	0.17
C.D. at 5%	NS	NS	NS	NS	0.60	NS
K_1	21.64	23.31	22.47	23.99	25.68	24.84
K_2	22.44	24.97	23.71	24.51	26.47	25.49
K_3	24.14	24.17	24.16	25.12	27.49	26.30
S.Em.±	0.52	0.45	0.38	0.32	0.26	0.20
C.D. at 5%	1.50	1.29	1.08	NS	0.74	0.59
N_1P_1	19.60	20.73	20.16	20.81	22.23	21.52
N_1P_2	20.04	21.24	20.64	21.56	23.34	22.45
N_2P_1	21.89	23.52	22.70	23.81	25.43	24.62
N_2P_2	24.64	24.71	24.68	25.33	27.75	26.54
N_3P_1	25.79	27.48	26.63	28.63	31.03	29.83
N_3P_2	24.50	27.24	25.87	27.12	29.49	28.30
S.Em.±	0.74	0.64	0.53	0.45	0.36	0.29
C.D. at 5%	2.12	NS	1.52	1.30	1.04	0.83
N_1K_1	18.64	19.61	19.12	20.11	21.66	20.88
N_1K_2	19.78	21.12	20.45	21.29	22.50	21.90
N_1K_3	21.04	22.22	21.63	22.17	24.19	23.18
N_2K_1	21.89	23.19	22.54	23.65	25.47	24.56
N_2K_2	22.58	24.17	23.37	23.72	25.97	24.84
N_2K_3	25.32	24.98	25.15	26.34	28.34	27.34
N_3K_1	24.39	27.13	25.76	28.21	29.91	29.06
N_3K_2	24.97	29.63	27.30	28.54	30.94	29.74
N_3K_3	26.07	25.33	25.70	26.86	29.93	28.40
S.Em.±	0.90	0.78	0.65	0.56	0.44	0.35
C.D. at 5%	NS	2.24	NS	1.60	1.28	1.02
P_1K_1	20.45	23.00	21.73	23.48	25.03	24.26
P_1K_2	23.32	24.96	24.14	24.51	26.61	25.56
P_1K_3	23.51	23.76	23.63	25.26	27.05	26.16
P_2K_1	22.83	23.62	23.22	24.50	26.33	25.42
P_2K_2	21.56	24.99	23.28	24.52	26.33	25.43
P_2K_3	24.78	24.59	24.69	24.98	27.92	26.45
S.Em.±	0.74	0.64	0.53	0.79	0.36	0.29
C.D. at 5%	2.12	NS	NS	NS	NS	NS
$N_1P_1K_1$	18.29	19.56	18.92	19.49	20.78	20.14
$N_1P_1K_2$	19.83	20.60	20.21	20.96	22.38	21.67
$N_1P_1K_3$	20.69	22.02	21.36	21.99	23.52	22.76
$N_1P_2K_1$	18.99	19.66	19.32	20.73	22.54	21.63
$N_1P_2K_2$	19.73	21.64	20.69	21.61	22.63	22.12
$N_1P_2K_3$	21.38	22.41	21.90	22.34	24.86	23.60
$N_2P_1K_1$	20.63	21.62	21.12	22.79	24.56	23.68
$N_2P_1K_2$	21.68	23.44	22.56	22.65	24.84	23.74
$N_2P_1K_3$	23.35	25.51	24.43	25.98	26.91	26.45
$N_2P_2K_1$	23.16	24.77	23.97	24.52	26.38	25.45
$N_2P_2K_2$	23.48	24.91	24.19	24.78	27.10	25.94
$N_2P_2K_3$	27.28	24.45	25.87	26.69	29.77	28.23
$N_3P_1K_1$	22.43	27.83	25.13	28.17	29.75	28.96
$N_3P_1K_2$	28.46	30.84	29.65	29.91	32.61	31.26
$N_3P_1K_3$	26.47	23.75	25.11	27.80	30.74	29.27
$N_3P_2K_1$	26.34	26.42	26.38	28.26	30.06	29.16
$N_3P_2K_2$	21.48	28.41	24.95	27.17	29.27	28.22
$N_3P_2K_3$	25.67	26.90	26.29	25.92	29.13	27.53
S.Em.±	1.28	1.10	0.92	0.79	0.63	0.50
C.D. at 5%	3.67	3.17	2.64	2.26	1.80	1.44
Control	10.74	11.43	11.09	16.88	17.30	17.09
S.Em.±	1.25	1.08	0.89	0.76	0.61	0.49
C.D. at 5%	3.58	3.09	2.56	2.19	1.76	1.40

Note: FYM – 5 t ha^{-1};N_1 – 100 kg ha^{-1}; N_2 – 125 kg ha^{-1} ; N_3- 150 kg ha^{-1} ; P_1 – 50 kg ha^{-1} ; P_2 – 75 kg ha^{-1} ; K_1 – 50 kg ha^{-1}; K_2 – 75 kg ha^{-1} ; K_3 - 100 kg ha^{-1} ; NS – Non significant ; DAS – Days after sowing.

Table 5. Potassium uptake by Bt cotton as influenced by different levels of NPK at 60 and 90 DAS in Alfisol.

Treatments	Potassium uptake (kg ha^{-1})					
	60 DAS			90 DAS		
	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled
N_1	26.44	27.86	27.15	70.73	72.14	71.44
N_2	28.52	30.03	29.27	73.63	77.05	75.34
N_3	30.18	31.74	30.96	77.39	79.43	78.41
S.Em.±	0.29	0.32	0.22	0.56	0.57	0.40
C.D. at 5%	0.84	0.91	0.62	1.62	1.65	1.15
P_1	28.38	30.11	29.25	73.36	76.46	74.91
P_2	28.38	29.64	29.01	74.47	75.96	75.22
S.Em.±	0.24	0.26	0.18	0.46	0.47	0.33
C.D. at 5%	NS	NS	NS	NS	NS	NS
K_1	27.40	28.80	28.10	72.23	75.21	73.72
K_2	28.40	29.84	29.12	74.22	76.59	75.26
K_3	29.33	30.99	30.16	75.30	77.12	76.21
S.Em.±	0.29	0.32	0.22	0.56	0.57	0.40
C.D. at 5%	0.84	0.91	0.62	1.62	NS	1.15
N_1P_1	26.21	27.62	26.91	70.56	71.96	71.26
N_1P_2	26.67	28.10	27.38	70.91	72.32	71.61
N_2P_1	28.24	29.99	29.12	71.79	76.29	74.04
N_2P_2	28.79	30.07	29.43	75.47	77.81	76.64
N_3P_1	30.68	32.73	31.70	77.74	81.13	79.43
N_3P_2	29.68	30.76	30.22	77.05	77.74	77.39
S.Em.±	0.41	0.45	0.31	0.80	0.81	0.57
C.D. at 5%	NS	1.28	0.88	2.29	2.33	1.62
N_1K_1	25.20	26.43	25.81	68.09	69.85	68.97
N_1K_2	26.12	27.57	26.84	70.79	72.53	71.66
N_1K_3	28.00	29.58	28.79	73.32	74.04	73.68
N_2K_1	27.14	28.38	27.76	71.91	77.06	74.48
N_2K_2	28.32	29.51	28.91	73.72	75.67	74.70
N_2K_3	30.08	32.21	31.15	75.26	78.43	76.85
N_3K_1	29.87	31.60	30.74	76.69	78.74	77.72
N_3K_2	30.76	32.45	31.61	78.17	80.66	79.41
N_3K_3	29.90	31.18	30.54	77.32	78.90	78.11
S.Em.±	0.50	0.55	0.38	0.98	0.99	0.69
C.D. at 5%	1.45	1.57	1.08	NS	NS	1.99
P_1K_1	27.05	28.38	27.72	71.23	75.83	73.53
P_1K_2	28.71	30.75	29.73	73.85	76.54	75.20
P_1K_3	29.37	31.21	30.29	75.01	77.00	76.01
P_2K_1	27.76	29.22	28.49	73.23	74.59	73.91
P_2K_2	28.09	28.94	28.52	74.60	76.03	75.31
P_2K_3	29.28	30.77	30.02	75.59	77.24	76.42
S.Em.±	0.41	0.45	0.31	0.80	0.81	0.57
C.D. at 5%	NS	1.28	0.88	NS	NS	NS
$N_1P_1K_1$	24.71	25.50	25.10	66.30	69.57	67.94
$N_1P_1K_2$	25.98	28.02	27.00	70.68	72.16	71.42
$N_1P_1K_3$	27.94	29.35	28.64	74.70	74.14	74.42
$N_1P_2K_1$	25.69	27.35	26.52	69.88	70.12	70.00
$N_1P_2K_2$	26.25	27.11	26.68	70.89	72.90	71.89
$N_1P_2K_3$	28.06	29.82	28.94	71.94	73.94	72.94
$N_2P_1K_1$	26.92	28.14	27.53	70.49	78.66	74.57
$N_2P_1K_2$	28.35	29.69	29.02	71.65	73.82	72.73
$N_2P_1K_3$	29.45	32.15	30.80	73.25	76.41	74.83
$N_2P_2K_1$	27.37	28.62	27.99	73.33	75.45	74.39
$N_2P_2K_2$	28.29	29.32	28.81	75.79	77.53	76.66
$N_2P_2K_3$	30.72	32.27	31.49	77.28	80.46	78.87
$N_3P_1K_1$	29.52	31.51	30.51	76.90	79.27	78.09
$N_3P_1K_2$	31.79	34.53	33.16	79.24	83.64	81.44
$N_3P_1K_3$	30.73	32.15	31.44	77.08	80.47	78.77
$N_3P_2K_1$	30.22	31.69	30.96	76.48	78.21	77.34
$N_3P_2K_2$	29.74	30.38	30.06	77.10	77.67	77.39
$N_3P_2K_3$	29.07	30.21	29.64	77.56	77.33	77.45
S.Em.±	0.71	0.77	0.53	1.38	1.41	0.98
C.D. at 5%	NS	NS	NS	NS	4.04	2.81
Control	19.52	20.16	19.84	48.08	50.14	49.11
S.Em.±	0.70	0.77	0.52	1.47	1.38	0.99
C.D. at 5%	2.00	2.21	1.49	4.20	3.95	2.83

Note: FYM – 5 t ha^{-1};N_1 – 100 kg ha^{-1}; N_2 – 125 kg ha^{-1} ; N_3- 150 kg ha^{-1} ; P_1 – 50 kg ha^{-1} ; P_2 – 75 kg ha^{-1} ; K_1 – 50 kg ha^{-1}; K_2 – 75 kg ha^{-1} ; K_3 - 100 kg ha^{-1} ; NS – Non significant ; DAS – Days after sowing.

Table 6. Potassium uptake by Bt cotton as influenced by different levels of NPK at 120 DAS and harvest in Alfisol.

Treatments	Potassium uptake (kg ha^{-1})					
	120 DAS			At harvest		
	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled
N_1	114.26	117.01	115.64	115.95	118.13	117.04
N_2	118.69	121.43	120.06	120.24	122.33	121.28
N_3	122.68	125.14	123.91	123.81	126.92	125.37
S.Em.±	0.60	1.29	0.69	0.38	0.41	0.28
C.D. at 5%	1.71	3.69	1.98	1.09	1.16	0.82
P_1	117.87	120.29	119.08	119.21	121.53	120.37
P_2	119.21	122.10	120.66	120.79	123.39	122.09
S.Em.±	0.49	1.05	0.56	0.31	0.33	0.23
C.D. at 5%	NS	NS	NS	0.89	0.95	0.67
K_1	117.10	120.00	118.55	118.70	120.65	119.68
K_2	118.83	121.30	120.06	120.51	122.64	121.58
K_3	119.70	122.29	120.99	120.78	124.08	122.43
S.Em.±	0.60	1.29	0.69	0.38	0.41	0.28
C.D. at 5%	1.71	3.69	1.98	1.09	1.16	0.82
N_1P_1	113.14	115.47	114.30	115.37	117.69	116.53
N_1P_2	115.38	118.56	116.97	116.53	118.56	117.55
N_2P_1	116.06	118.85	117.45	117.65	119.66	118.65
N_2P_2	121.32	124.01	122.66	122.82	124.99	123.91
N_3P_1	124.42	126.54	125.48	124.62	127.24	125.93
N_3P_2	120.94	123.74	122.34	123.01	126.60	124.81
S.Em.±	0.84	1.82	0.97	0.54	0.57	0.40
C.D. at 5%	2.42	5.22	2.80	1.54	1.65	1.15
N_1K_1	112.50	115.86	114.18	115.16	116.85	116.01
N_1K_2	114.66	116.82	115.74	116.10	117.86	116.98
N_1K_3	115.62	118.35	116.98	116.59	119.67	118.13
N_2K_1	116.37	119.41	117.89	118.13	120.44	119.29
N_2K_2	118.31	121.06	119.69	120.12	121.71	120.92
N_2K_3	121.38	123.82	122.60	122.46	124.82	123.64
N_3K_1	122.42	124.73	123.57	122.82	124.67	123.74
N_3K_2	123.51	126.01	124.76	125.32	128.35	126.84
N_3K_3	122.11	124.69	123.40	123.29	127.74	125.52
S.Em.±	1.03	2.23	1.19	0.66	0.70	0.49
C.D. at 5%	NS	NS	3.42	1.89	NS	1.41
P_1K_1	115.94	118.76	117.35	117.11	119.00	118.05
P_1K_2	118.80	120.91	119.85	120.29	122.31	121.30
P_1K_3	118.87	121.19	120.03	120.24	123.28	121.76
P_2K_1	118.26	121.24	119.75	120.30	122.30	121.30
P_2K_2	118.86	121.68	120.27	120.74	122.98	121.86
P_2K_3	120.53	123.38	121.96	121.32	124.88	123.10
S.Em.±	0.84	1.82	0.97	0.54	0.57	0.40
C.D. at 5%	NS	NS	NS	1.54	NS	1.15
$N_1P_1K_1$	111.61	114.72	113.16	114.72	116.60	115.66
$N_1P_1K_2$	113.63	114.97	114.30	115.33	117.40	116.36
$N_1P_1K_3$	114.17	116.72	115.44	116.06	119.08	117.57
$N_1P_2K_1$	113.39	117.01	115.20	115.60	117.11	116.35
$N_1P_2K_2$	115.69	118.67	117.18	116.87	118.32	117.59
$N_1P_2K_3$	117.06	119.99	118.53	117.12	120.27	118.69
$N_2P_1K_1$	113.34	116.48	114.91	115.53	118.22	116.87
$N_2P_1K_2$	116.31	119.32	117.82	117.93	119.25	118.59
$N_2P_1K_3$	118.52	120.75	119.64	119.48	121.52	120.50
$N_2P_2K_1$	119.41	122.34	120.88	120.73	122.67	121.70
$N_2P_2K_2$	120.32	122.79	121.55	122.31	124.18	123.25
$N_2P_2K_3$	124.24	126.88	125.56	125.43	128.13	126.78
$N_3P_1K_1$	122.88	125.07	123.98	121.07	122.20	121.63
$N_3P_1K_2$	126.46	128.44	127.45	127.60	130.27	128.94
$N_3P_1K_3$	123.92	126.11	125.02	125.18	129.24	127.21
$N_3P_2K_1$	121.97	124.38	123.17	124.57	127.14	125.86
$N_3P_2K_2$	120.56	123.58	122.07	123.05	126.44	124.74
$N_3P_2K_3$	120.29	123.27	121.78	121.41	126.24	123.82
S.Em.±	1.46	3.15	1.69	0.93	0.99	0.69
C.D. at 5%	4.19	NS	4.84	2.67	2.85	2.00
Control	94.81	98.42	96.61	109.18	111.41	110.29
S.Em.±	1.56	3.07	1.67	0.92	1.02	0.72
C.D. at 5%	4.49	8.80	4.80	2.64	2.94	2.07

Note: FYM – 5 t ha^{-1};N_1 – 100 kg ha^{-1}; N_2 – 125 kg ha^{-1} ; N_3- 150 kg ha^{-1} ; P_1 – 50 kg ha^{-1} ; P_2 – 75 kg ha^{-1} ; K_1 – 50 kg ha^{-1}; K_2 – 75 kg ha^{-1} ; K_3 - 100 kg ha^{-1} ; NS – Non significant ; DAS – Days after sowing.

Table 7. Physico-chemical parameters as influenced by different levels of NPK at harvest of Bt cotton in Alfisol.

Treatments	pH (1:2.5)			EC (dSm^{-1}) (1:2.5)			Organic carbon ($g\ kg^{-1}$)		
	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled
N_1	6.48	5.76	6.12	0.14	0.13	0.13	6.12	5.86	5.99
N_2	6.44	5.76	6.10	0.13	0.14	0.13	6.05	5.82	5.94
N_3	6.46	5.78	6.12	0.13	0.13	0.13	6.05	5.81	5.93
S.Em.±	0.02	0.02	0.02	0.004	0.004	0.003	0.006	0.008	0.005
C.D. at 5%	NS	NS	NS	NS	NS	NS	0.018	0.023	0.015
P_1	6.45	5.80	6.13	0.13	0.13	0.13	6.07	5.83	5.95
P_2	6.47	5.73	6.10	0.14	0.13	0.13	6.07	5.83	5.95
S.Em.±	0.01	0.02	0.01	0.004	0.003	0.002	0.005	0.007	0.004
C.D. at 5%	NS	0.06	NS	NS	NS	NS	NS	NS	NS
K_1	6.45	5.81	6.13	0.13	0.13	0.13	6.08	5.85	5.97
K_2	6.44	5.78	6.11	0.13	0.14	0.13	6.07	5.82	5.95
K_3	6.49	5.72	6.10	0.13	0.13	0.13	6.06	5.81	5.94
S.Em.±	0.02	0.02	0.02	0.004	0.004	0.003	0.006	0.008	0.005
C.D. at 5%	NS	NS	NS	NS	NS	NS	0.018	0.023	0.015
N_1P_1	6.49	5.83	6.16	0.13	0.13	0.13	6.12	5.87	6.00
N_1P_2	6.47	5.69	6.08	0.15	0.14	0.14	6.11	5.85	5.98
N_2P_1	6.42	5.80	6.11	0.13	0.13	0.13	6.05	5.82	5.94
N_2P_2	6.45	5.73	6.09	0.14	0.14	0.14	6.05	5.82	5.94
N_3P_1	6.43	5.79	6.11	0.13	0.14	0.13	6.04	5.79	5.92
N_3P_2	6.49	5.78	6.13	0.12	0.12	0.12	6.06	5.83	5.94
S.Em.±	0.02	0.03	0.02	0.006	0.005	0.004	0.009	0.011	0.007
C.D. at 5%	NS	NS	NS	NS	0.01	0.01	NS	NS	0.021
N_1K_1	6.44	5.71	6.07	0.13	0.13	0.13	6.13	5.89	6.01
N_1K_2	6.43	5.84	6.13	0.14	0.14	0.14	6.12	5.85	5.99
N_1K_3	6.57	5.74	6.15	0.14	0.13	0.14	6.09	5.83	5.96
N_2K_1	6.42	5.87	6.14	0.13	0.13	0.13	6.06	5.84	5.95
N_2K_2	6.48	5.71	6.10	0.13	0.15	0.14	6.05	5.82	5.94
N_2K_3	6.42	5.72	6.07	0.13	0.13	0.13	6.04	5.80	5.92
N_3K_1	6.48	5.85	6.16	0.14	0.14	0.14	6.06	5.83	5.94
N_3K_2	6.42	5.78	6.10	0.12	0.13	0.13	6.04	5.80	5.92
N_3K_3	6.48	5.71	6.09	0.12	0.13	0.12	6.05	5.81	5.93
S.Em.±	0.03	0.04	0.03	0.008	0.006	0.004	0.011	0.014	0.009
C.D. at 5%	0.08	0.12	0.08	NS	NS	NS	NS	NS	NS
P_1K_1	6.44	5.83	6.14	0.13	0.13	0.13	6.09	5.86	5.97
P_1K_2	6.41	5.83	6.12	0.13	0.14	0.13	6.06	5.81	5.94
P_1K_3	6.49	5.75	6.12	0.12	0.12	0.12	6.06	5.81	5.94
P_2K_1	6.45	5.78	6.12	0.14	0.13	0.14	6.08	5.85	5.96
P_2K_2	6.47	5.73	6.10	0.13	0.13	0.13	6.08	5.83	5.96
P_2K_3	6.48	5.69	6.09	0.14	0.13	0.14	6.06	5.81	5.94
S.Em.±	0.02	0.03	0.02	0.006	0.005	0.004	0.009	0.011	0.007
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS
$N_1P_1K_1$	6.48	5.76	6.12	0.13	0.13	0.13	6.13	5.91	6.02
$N_1P_1K_2$	6.40	5.91	6.16	0.12	0.14	0.13	6.12	5.86	5.99
$N_1P_1K_3$	6.58	5.80	6.19	0.13	0.12	0.13	6.12	5.84	5.98
$N_1P_2K_1$	6.41	5.65	6.03	0.14	0.14	0.14	6.13	5.87	6.00
$N_1P_2K_2$	6.45	5.76	6.11	0.15	0.13	0.14	6.12	5.84	5.98
$N_1P_2K_3$	6.56	5.67	6.11	0.16	0.13	0.15	6.07	5.82	5.95
$N_2P_1K_1$	6.40	5.89	6.15	0.12	0.12	0.12	6.06	5.84	5.95
$N_2P_1K_2$	6.43	5.79	6.11	0.14	0.15	0.14	6.05	5.82	5.93
$N_2P_1K_3$	6.44	5.72	6.08	0.11	0.12	0.12	6.03	5.81	5.92
$N_2P_2K_1$	6.43	5.85	6.14	0.14	0.13	0.14	6.06	5.84	5.95
$N_2P_2K_2$	6.53	5.63	6.08	0.13	0.15	0.14	6.05	5.83	5.94
$N_2P_2K_3$	6.39	5.71	6.05	0.14	0.15	0.15	6.04	5.79	5.92
$N_3P_1K_1$	6.45	5.84	6.15	0.14	0.14	0.14	6.06	5.82	5.94
$N_3P_1K_2$	6.40	5.77	6.09	0.12	0.14	0.13	6.02	5.77	5.89
$N_3P_1K_3$	6.44	5.74	6.09	0.12	0.13	0.13	6.03	5.79	5.91
$N_3P_2K_1$	6.52	5.85	6.18	0.13	0.13	0.13	6.05	5.83	5.94
$N_3P_2K_2$	6.43	5.79	6.11	0.12	0.12	0.12	6.07	5.83	5.95
$N_3P_2K_3$	6.51	5.69	6.10	0.11	0.12	0.12	6.06	5.82	5.94
S.Em.±	0.04	0.06	0.04	0.011	0.009	0.006	0.015	0.020	0.013
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS
Control	6.44	5.60	6.02	0.16	0.13	0.15	6.15	5.87	5.79
S.Em.±	0.04	0.06	0.04	0.011	0.009	0.006	0.015	0.021	0.013
C.D. at 5%	0.11	0.18	0.11	0.03	0.02	0.02	0.044	0.059	0.037

Note: FYM – 5 t ha^{-1};N_1 – 100 kg ha^{-1}; N_2 – 125 kg ha^{-1} ; N_3- 150 kg ha^{-1} ; P_1 – 50 kg ha^{-1} ; P_2 – 75 kg ha^{-1} ; K_1 – 50 kg ha^{-1}; K_2 – 75 kg ha^{-1} ; K_3 - 100 kg ha^{-1} ; NS – Non significant ; DAS – Days after sowing, Initial soil properties (2012): pH- 6.27; EC- 0.10 dS m^{-1}; Organic carbon – 6.08 g kg^{-1}(2013): pH- 5.72; EC- 0.11 dS m^{-1}; Organic carbon – 5.88 g kg^{-1}

Table 8. Available nutrients status as influenced by different levels of NPK at harvest of Bt cotton in Alfisol.

Treatments	Available nitrogen (kg ha^{-1})			Available phosphorus(P_2O_5)(kgha^{-1})			Available potassium (K_2O) (kg ha^{-1})		
	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled
N_1	151.51	140.66	146.09	37.50	35.36	36.43	237.50	217.90	227.70
N_2	146.61	137.89	142.25	35.09	33.24	34.17	233.64	214.28	223.96
N_3	141.91	136.47	139.19	34.24	32.62	33.43	232.48	210.57	221.53
S.Em.±	0.32	0.29	0.25	0.15	0.19	0.10	0.27	0.56	0.30
C.D. at 5%	0.93	0.82	0.73	0.43	0.55	0.30	0.76	1.61	0.86
P_1	147.59	138.50	143.05	35.98	33.90	34.94	234.67	214.86	224.77
P_2	145.77	138.18	141.97	35.24	33.58	34.41	234.41	213.64	224.03
S.Em.±	0.26	0.23	0.21	0.12	0.16	0.08	0.22	0.46	0.24
C.D. at 5%	0.76	NS	0.60	0.35	NS	0.24	NS	NS	0.70
K_1	150.14	140.62	145.38	36.59	34.74	35.66	235.88	217.00	226.44
K_2	146.43	137.80	142.11	35.30	33.42	34.36	233.99	213.78	223.88
K_3	143.48	136.60	140.04	34.93	33.06	34.00	233.76	211.97	222.87
S.Em.±	0.32	0.29	0.25	0.15	0.19	0.10	0.27	0.56	0.30
C.D. at 5%	0.93	0.82	0.73	0.43	0.55	0.30	0.76	1.61	0.86
N_1P_1	152.30	140.97	146.64	37.97	35.77	36.87	237.63	218.95	228.29
N_1P_2	150.72	140.36	145.54	37.03	34.95	35.99	237.37	216.85	227.11
N_2P_1	149.30	138.79	144.04	36.22	33.26	34.74	234.59	215.36	224.98
N_2P_2	143.92	137.00	140.46	33.96	33.22	33.59	232.70	213.20	222.95
N_3P_1	141.17	135.75	138.46	33.74	32.67	33.20	231.80	210.26	221.03
N_3P_2	142.66	137.19	139.92	34.73	32.57	33.65	233.17	210.88	222.03
S.Em.±	0.46	0.40	0.36	0.21	0.27	0.15	0.38	0.79	0.42
C.D. at 5%	1.32	1.16	1.04	0.60	NS	0.42	1.08	NS	1.22
N_1K_1	156.14	143.03	149.58	38.68	36.51	37.60	238.61	221.00	229.81
N_1K_2	151.47	140.92	146.19	37.30	35.45	36.37	237.47	218.10	227.78
N_1K_3	146.94	138.05	142.49	36.54	34.11	35.32	236.42	214.59	225.51
N_2K_1	150.59	140.13	145.36	35.89	34.31	35.10	235.09	217.31	226.20
N_2K_2	147.48	137.91	142.69	35.03	33.23	34.13	233.91	214.74	224.32
N_2K_3	141.77	135.63	138.70	34.35	32.19	33.27	231.94	210.80	221.37
N_3K_1	143.69	138.72	141.20	35.21	33.39	34.30	233.93	212.69	223.31
N_3K_2	140.33	134.57	137.45	33.59	31.59	32.59	230.59	208.52	219.55
N_3K_3	141.72	136.12	138.92	33.91	32.89	33.40	232.93	210.52	221.73
S.Em.±	0.56	0.50	0.44	0.26	0.33	0.18	0.46	0.97	0.52
C.D. at 5%	1.61	1.42	1.27	NS	0.95	0.52	1.32	2.78	1.49
P_1K_1	152.05	141.35	146.70	37.00	34.91	35.96	236.20	218.14	227.17
P_1K_2	146.70	137.33	142.01	35.44	33.28	34.36	233.96	213.61	223.78
P_1K_3	144.02	136.83	140.43	35.49	33.51	34.50	233.86	212.82	223.34
P_2K_1	148.22	139.90	144.06	36.19	34.56	35.37	235.55	215.85	225.70
P_2K_2	146.15	138.27	142.21	35.17	33.56	34.37	234.02	213.96	223.99
P_2K_3	142.93	136.37	139.65	34.37	32.62	33.49	233.67	211.12	222.39
S.Em.±	0.46	0.40	0.36	0.21	0.27	0.15	0.38	0.79	0.42
C.D. at 5%	1.32	1.16	1.04	NS	NS	0.42	NS	NS	NS
$N_1P_1K_1$	157.28	143.50	150.39	38.73	37.22	37.98	239.10	222.88	230.99
$N_1P_1K_2$	152.49	140.86	146.67	37.68	35.59	36.63	237.57	218.41	227.99
$N_1P_1K_3$	147.15	138.55	142.85	37.51	34.51	36.01	236.22	215.55	225.89
$N_1P_2K_1$	154.99	142.55	148.77	38.62	35.81	37.22	238.13	219.12	228.63
$N_1P_2K_2$	150.45	140.98	145.71	36.91	35.32	36.12	237.36	217.78	227.57
$N_1P_2K_3$	146.74	137.54	142.14	35.56	33.71	34.64	236.61	213.64	225.13
$N_2P_1K_1$	153.46	140.96	147.21	36.92	34.18	35.55	235.60	217.70	226.65
$N_2P_1K_2$	150.05	138.83	144.44	36.27	33.33	34.80	235.14	216.30	225.72
$N_2P_1K_3$	144.40	136.57	140.49	35.46	32.27	33.86	233.02	212.09	222.56
$N_2P_2K_1$	147.72	139.31	143.51	34.86	34.43	34.65	234.57	216.92	225.75
$N_2P_2K_2$	144.90	136.99	140.95	33.78	33.12	33.45	232.67	213.17	222.92
$N_2P_2K_3$	139.14	134.69	136.92	33.24	32.11	32.68	230.85	209.51	220.18
$N_3P_1K_1$	145.42	139.59	142.51	35.35	33.34	34.34	233.92	213.85	223.89
$N_3P_1K_2$	137.56	132.29	134.92	32.36	30.93	31.65	229.15	206.11	217.63
$N_3P_1K_3$	140.52	135.37	137.95	33.51	33.74	33.62	232.32	210.83	221.58
$N_3P_2K_1$	141.96	137.84	139.90	35.08	33.44	34.26	233.94	211.52	222.73
$N_3P_2K_2$	143.11	136.85	139.98	34.82	32.25	33.53	232.03	210.92	221.47
$N_3P_2K_3$	142.91	136.88	139.89	34.30	32.04	33.17	233.54	210.21	221.88
S.Em.±	0.79	0.70	0.62	0.36	0.47	0.25	0.65	1.37	0.73
C.D. at 5%	2.28	2.01	1.80	1.04	1.34	0.73	1.87	3.94	2.11
Control	128.04	115.67	121.86	25.54	20.55	23.05	210.33	177.60	193.97
S.Em.±	0.79	0.68	0.61	0.37	0.47	0.27	0.68	1.34	0.73
C.D. at 5%	2.25	1.96	1.76	1.07	1.35	0.79	1.94	3.86	2.11

Note: FYM – 5 t ha^{-1};N_1 – 100 kg ha^{-1}; N_2 – 125 kg ha^{-1} ; N_3- 150 kg ha^{-1} ; P_1 – 50 kg ha^{-1} ; P_2 – 75 kg ha^{-1} ; K_1 – 50 kg ha^{-1}; K_2 – 75 kg ha^{-1} ; K_3 - 100 kg ha^{-1} ; NS – Non significant ; DAS – Days after sowing, Initial soil nutrients status (2012) :Available nitrogen – 131.40 kg ha^{-1}; Available P_2O_5 – 28.60 kg ha^{-1}; Available K_2O – 208.90 kg ha^{-1}, (2013) :Available nitrogen – 119.26 kg ha^{-1}; Available P_2O_5 – 25.40 kg ha^{-1}; Available K_2O – 181.22 kg ha^{-1}.

Table 9. DTPA extractable micronutrients status as influenced by different levels of NPK at harvest of Bt cotton in Alfisol.

Treatments	DTPA extractable micronutrients (mg kg^{-1})											
	Zinc			Iron			Manganese			Copper		
	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled
N_1	0.53	0.53	0.53	4.61	7.59	6.10	9.23	14.40	11.81	1.25	1.22	1.24
N_2	0.52	0.52	0.52	4.38	7.47	5.92	9.21	14.09	11.65	1.22	1.22	1.22
N_3	0.52	0.52	0.52	4.18	7.42	5.80	9.21	14.16	11.69	1.22	1.20	1.21
S.Em.±	0.003	0.002	0.002	0.07	0.05	0.05	0.006	0.14	0.07	0.006	0.008	0.006
C.D. at 5%	NS	NS	NS	0.21	NS	0.13	NS	NS	NS	0.016	NS	0.017
P_1	0.53	0.52	0.52	4.45	7.50	5.97	9.21	14.15	11.68	1.23	1.22	1.23
P_2	0.52	0.52	0.52	4.33	7.49	5.91	9.22	14.28	11.75	1.23	1.21	1.22
S.Em.±	0.002	0.002	0.002	0.06	0.04	0.04	0.005	0.11	0.06	0.005	0.006	0.005
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
K_1	0.54	0.53	0.53	4.48	7.55	6.02	9.24	14.53	11.88	1.25	1.24	1.24
K_2	0.52	0.52	0.52	4.36	7.47	5.91	9.21	14.16	11.69	1.23	1.21	1.22
K_3	0.52	0.51	0.52	4.32	7.46	5.89	9.20	14.00	11.59	1.21	1.20	1.21
S.Em.±	0.003	0.002	0.002	0.07	0.05	0.05	0.006	0.14	0.07	0.006	0.008	0.006
C.D. at 5%	0.008	0.007	0.006	NS	NS	NS	0.018	0.40	0.20	0.016	0.022	0.017
N_1P_1	0.53	0.53	0.53	4.69	7.61	6.15	9.23	14.45	11.84	1.26	1.23	1.24
N_1P_2	0.52	0.52	0.52	4.52	7.56	6.04	9.22	14.36	11.79	1.25	1.22	1.23
N_2P_1	0.52	0.52	0.52	4.48	7.48	5.98	9.22	14.21	11.71	1.23	1.23	1.23
N_2P_2	0.53	0.52	0.52	4.28	7.45	5.86	9.21	13.96	11.59	1.21	1.21	1.21
N_3P_1	0.52	0.51	0.52	4.18	7.40	5.79	9.20	13.81	11.50	1.20	1.20	1.20
N_3P_2	0.52	0.53	0.53	4.18	7.45	5.81	9.23	14.52	11.88	1.23	1.21	1.22
S.Em.±	0.004	0.003	0.003	0.11	0.07	0.06	0.009	0.20	0.10	0.008	0.011	0.008
C.D. at 5%	NS	0.010	0.008	NS	NS	NS	0.025	0.56	0.29	0.023	NS	NS
N_1K_1	0.53	0.54	0.54	4.71	7.65	6.18	9.25	14.61	11.93	1.27	1.24	1.25
N_1K_2	0.53	0.52	0.53	4.58	7.57	6.08	9.23	14.45	11.84	1.26	1.23	1.24
N_1K_3	0.52	0.51	0.52	4.53	7.54	6.03	9.20	14.14	11.67	1.23	1.21	1.22
N_2K_1	0.54	0.53	0.53	4.50	7.51	6.01	9.24	14.50	11.87	1.25	1.24	1.24
N_2K_2	0.53	0.52	0.52	4.36	7.48	5.92	9.22	14.07	11.64	1.22	1.23	1.23
N_2K_3	0.51	0.51	0.51	4.27	7.41	5.84	9.18	13.69	11.44	1.20	1.19	1.20
N_3K_1	0.54	0.52	0.53	4.24	7.49	5.86	9.22	14.46	11.84	1.24	1.23	1.24
N_3K_2	0.51	0.51	0.51	4.14	7.36	5.75	9.20	13.95	11.58	1.21	1.18	1.19
N_3K_3	0.52	0.52	0.52	4.17	7.42	5.79	9.21	14.08	11.65	1.21	1.20	1.20
S.Em.±	0.005	0.004	0.003	0.13	0.09	0.08	0.011	0.24	0.12	0.010	0.013	0.010
C.D. at 5%	0.015	0.012	0.010	NS	NS	NS	NS	NS	NS	NS	NS	NS
P_1K_1	0.54	0.53	0.53	4.55	7.56	6.06	9.24	14.49	11.86	1.25	1.24	1.25
P_1K_2	0.52	0.51	0.51	4.41	7.47	5.94	9.21	14.03	11.62	1.23	1.21	1.22
P_1K_3	0.52	0.52	0.52	4.38	7.46	5.92	9.20	13.94	11.57	1.22	1.21	1.21
P_2K_1	0.53	0.53	0.53	4.42	7.54	5.98	9.24	14.56	11.90	1.25	1.23	1.24
P_2K_2	0.53	0.52	0.53	4.30	7.47	5.89	9.22	14.28	11.75	1.23	1.21	1.22
P_2K_3	0.52	0.51	0.51	4.26	7.45	5.86	9.20	14.00	11.60	1.21	1.19	1.20
S.Em.±	0.004	0.003	0.003	0.11	0.07	0.08	0.009	0.20	0.10	0.008	0.011	0.008
C.D. at 5%	NS	0.010	0.008	NS	NS	NS	NS	NS	NS	NS	NS	NS
$N_1P_1K_1$	0.54	0.54	0.54	4.79	7.66	6.23	9.25	14.65	11.95	1.27	1.24	1.26
$N_1P_1K_2$	0.53	0.52	0.53	4.66	7.60	6.13	9.23	14.56	11.89	1.26	1.23	1.25
$N_1P_1K_3$	0.53	0.52	0.52	4.61	7.57	6.09	9.21	14.13	11.67	1.24	1.21	1.23
$N_1P_2K_1$	0.53	0.54	0.53	4.63	7.64	6.13	9.25	14.57	11.91	1.26	1.23	1.25
$N_1P_2K_2$	0.53	0.53	0.53	4.50	7.54	6.02	9.22	14.34	11.78	1.26	1.22	1.24
$N_1P_2K_3$	0.52	0.51	0.52	4.44	7.51	5.98	9.20	14.16	11.68	1.23	1.20	1.21
$N_2P_1K_1$	0.54	0.53	0.53	4.58	7.52	6.05	9.24	14.52	11.88	1.26	1.25	1.25
$N_2P_1K_2$	0.52	0.52	0.52	4.47	7.50	5.99	9.23	14.18	11.71	1.24	1.24	1.24
$N_2P_1K_3$	0.51	0.51	0.51	4.39	7.43	5.91	9.19	13.92	11.56	1.21	1.21	1.21
$N_2P_2K_1$	0.53	0.53	0.53	4.42	7.51	5.97	9.23	14.48	11.86	1.24	1.22	1.23
$N_2P_2K_2$	0.53	0.52	0.53	4.25	7.45	5.85	9.21	13.96	11.58	1.21	1.22	1.21
$N_2P_2K_3$	0.51	0.50	0.51	4.16	7.39	5.77	9.18	13.46	11.32	1.19	1.18	1.18
$N_3P_1K_1$	0.54	0.52	0.53	4.28	7.50	5.89	9.22	14.29	11.76	1.23	1.23	1.23
$N_3P_1K_2$	0.50	0.48	0.49	4.11	7.31	5.71	9.17	13.36	11.27	1.19	1.15	1.17
$N_3P_1K_3$	0.53	0.52	0.52	4.15	7.40	5.77	9.20	13.77	11.48	1.21	1.21	1.21
$N_3P_2K_1$	0.54	0.53	0.53	4.20	7.48	5.84	9.23	14.63	11.93	1.25	1.23	1.24
$N_3P_2K_2$	0.52	0.53	0.52	4.16	7.42	5.79	9.22	14.55	11.89	1.22	1.20	1.21
$N_3P_2K_3$	0.52	0.53	0.52	4.18	7.45	5.82	9.23	14.39	11.81	1.21	1.20	1.20
S.Em.±	0.007	0.006	0.005	0.18	0.13	0.11	0.015	0.34	0.17	0.014	0.019	0.014
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Control	0.44	0.43	0.43	3.87	6.90	5.38	8.77	12.25	10.51	1.07	1.04	1.06
S.Em.±	0.008	0.006	0.005	0.18	0.13	0.11	0.030	0.33	0.17	0.014	0.018	0.014
C.D. at 5%	0.023	0.019	0.014	0.51	0.36	0.31	0.087	0.94	0.49	0.039	0.052	0.040

Note: FYM – 5 t ha^{-1};N_1 – 100 kg ha^{-1}; N_2 – 125 kg ha^{-1} ; N_3- 150 kg ha^{-1} ; P_1 – 50 kg ha^{-1} ; P_2 – 75 kg ha^{-1} ; K_1 – 50 kg ha^{-1}; K_2 – 75 kg ha^{-1} ; K_3 - 100 kg ha^{-1} ; NS – Non significant ; DAS – Days after sowing, Initial soil nutrients status (2012):DTPA Zn- 0.59 mg kg^{-1} ; DTPA Fe – 4.91 mg kg^{-1} ; DTPA Mn – 10.12 mg kg^{-1} ; DTPA Cu –1.30 mg kg^{-1} (2013):DTPA Zn- 0.57 mg kg^{-1} ; DTPA Fe – 7.56 mg kg^{-1} ; DTPA Mn – 14.28 mg kg^{-1} ; DTPA Cu – 1.23 mg kg^{-1}

pounds (ATP), which regulate photosynthesis. Gadhiya *et al.* (2009) revealed that among the three levels each of N (160, 200 and 240 kg ha^{-1}), an application of 240 kg N ha^{-1} registered significantly higher values of N, P and K uptake by cotton stalk on account of higher production of seed cotton yield and dry matter in medium black soils of Khedbhrahma (Gujarat). The positive response of K fertilizer @ 84 kg K ha^{-1} on K-deficient soils has been reported earlier by Reeves and Mullins (1995) in sandy loam soils of east-central Alabama. It is apparent that ability of soil to supply K^+ to the roots is more important in determining K uptake than ability of roots to absorb K^+ from soil solution to meet total K requirement of the crop calculated on the basis of mass flow (Barber, 1985). Moreover, the application of the whole dose of K fertilizer at sowing time enhanced the soil's ability to increase K^+ concentration in the solution; favouring N uptake for vigorous vegetative growth particularly during early part of the season (Ali *et al.*, 2007).

Effect of NPK fertilizers on fertility status of soil at harvest of Bt cotton in Alfisols: The available nitrogen, phosphorus and potassium in soil at harvest were significantly influenced by graded levels of NPK fertilizers but showed non significant effect on physico-chemical properties of soil (pH, EC and OC) (Table 7). The treatment $N_1P_1K_1$ (100:50:50 kg $N:P_2O_5:K_2O$ ha^{-1}) recorded significantly (P=0.05) higher available nitrogen (150.39 kg ha^{-1}), phosphorus (37.98 kg ha^{-1}) and potassium (230.99 kg ha^{-1}) compared to other treatments. The application of 150:50:75 kg $N:P_2O_5:K_2O$ ha^{-1} ($N_3P_1K_2$) recorded lower available nitrogen (134.92 kg ha^{-1}), phosphorus (31.65 kg ha^{-1}) and potassium (217.63 kg ha^{-1}) (Table 8). The interaction effect of graded levels of NPK fertilizers remained non significant for DTPA extractable micronutrients (Cu, Fe, Mn and Zn) (Table 9). The reason for lower available nutrients under these treatments might be due to the supply of these nutrients at higher levels and higher uptake by the crop.

Conclusion

From the experimental results it can be concluded that, the application of 150:50:75 kg $N:P_2O_5:K_2O$ ha^{-1} ($N_3P_1K_2$) recorded significantly higher nitrogen (132.63 kg ha^{-1}), phosphorus (31.26 kg ha^{-1}) and potassium (128.94 kg ha^{-1}) uptake by cotton. The treatment receiving 100:50:50 kg $N:P_2O_5:K_2O$ ha^{-1} ($N_1P_1K_1$) recorded significantly highest available nitrogen (150.39 kg ha^{-1}), available phosphorus (37.98 kg ha^{-1}) and available potassium (230.99 kg ha^{-1}) compared to rest of the treatments. The lowest available nitrogen (134.92 kg ha^{-1}), available phosphorus (31.65 kg ha^{-1}) and available potassium (217.63 kg ha^{-1}) were recorded in treatment receiving 150:50:75 kg $N:P_2O_5:K_2O$ ha^{-1} ($N_3P_1K_2$). The superiority of 150:50:75 kg $N:P_2O_5:K_2O$ ha^{-1} in improving uptake and soil properties over the other treatments except the one supplied with 125:75:100 kg $N:P_2O_5:K_2O$ ha^{-1}. Hence, both the treatments emphasizing that any of these two can be considered as optimum dose for Alfisols.

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