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Effect of macronutrients and manipulation of Morphoframe on yield, quality parameters, nutrient uptake and economics of *Bt* cotton (*Gossypium hirsutum* L.)

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Abstract
A field experiment was conducted during the *Kharif* 2016 at Agricultural College farm, Raichur. The results of this experiment revealed that application of 125 per cent RDF recorded significantly higher seed cotton yield (3420 kg ha^{-1}), nutrient uptake (154.24, 34.02 and 174.55 kg N, P and K ha^{-1}) and BC ratio (3.22) compared to 100 per cent RDF (3088 kg ha^{-1}, 138.97, 30.74 and 156.93 kg N, P and K ha^{-1} and 3.04, respectively), and 75 per cent RDF (2517 kg ha^{-1}, 114.06, 25.44 and 127.81 kg N, P and K ha^{-1} and 2.60, respectively). Foliar spray of mepiquat chloride @ 100ppm along with boron @ 0.1% at 70 and 90 DAS recorded significantly higher seed cotton yield (3318 kg ha^{-1}), nutrient uptake (148.69, 32.91 and 168.49 kg N, P and K ha^{-1}) and BC ratio (3.52) compared to other morphoframe manipulations except foliar spray of boron @ 0.1 % with nipping during 85-95 DAS (3274 kg ha^{-1}, 147.76, 32.52 and 167.38 kg N, P and K ha^{-1} and 3.51, respectively).

Keywords: RDF, morphoframe manipulation, Mepiquat chloride, boron and nipping

Introduction
Cotton (*Gossypium hirsutum* L.) is considered as an important fibre crop of India and Karnataka. It is the backbone of textile industries mainly because of its lint. India contributes 85 per cent of raw material to textile industry and it earns about 33 per cent of total foreign exchange (Anon., 2014-15) [2]. In India, cotton has an area of 11.88 m ha with a production of 35.2 m bales and productivity of 503 kg lint ha^{-1} during 2015-16 as against an area of 5.88 m ha with a production of 3.04 m bales and productivity of 88 kg ha^{-1} in 1950-51. In Karnataka, cotton occupies an area of 6.12 lakh ha with a production of 18.9 lakh bales and with productivity of 556 kg lint per ha (Anon., 2016) [3]. Cotton producers are currently faced with rising production cost and declining returns for their commodity. The reason for the low yield is mainly due to non-adoption of precise location specific production packages. Among the various production factors, fertilization and excessive vegetative growth beside climate play significant role. In cotton growing areas, imbalanced fertilization of crop also affected vegetative and reproductive growth, thereby causing low productivity. Balanced fertilization is one of the major key factors affecting cotton yields. Cotton suffers from various biotic and abiotic stresses right from the germination to maturity. The growth during the seedling establishment phase has a role to play in yield realization. A good plant frame would provide sufficient space for holding and catering the needs of the reproductive parts during the latter part of growth. As the cotton plant is photo insensitive they starts producing the reproductive parts irrespective of the environmental and physical conditions by 40-45 DAS. Hence, sufficient morph-frame will not be available for the plant to hold the reproductive parts. This leads the plants to reduced boll load and premature death. Cotton crop failures can be often related to excessive vegetative growth, so there is need of proper mar pho frame by altering the vegetative growth. Efficient cotton production packages from modern agronomy of cotton explore the avenues for realizing the potential crop yields. Looking towards increase in area of cotton, it was necessary to conduct experiment to know the effect of macronutrients and manipulation of more pho frame on growth and yield of *Bt* cotton (*Gossypium hirsutum* L.).

Material and Methods
A field experiment was conducted during the *Kharif* 2016 at Agricultural College farm, Raichur, situated on the latitude of $16^0 12^1$ N latitude, $77^0 20^1$ E longitude with an elevation of 389 meters above mean sea level and is located in North Eastern Dry Zone of Karnataka.

The Experiment was laid out in factorial RCBD with 18 treatments replicated thrice. The studies included three RDF levels (F_1: 75 % RDF, F_2: 100 % RDF (180:90:90 kg NPK ha^{-1}), F_3: 125 % RDF) and six mor pho frame manipulation practices (B_1: Control, B_2: Mepiquat chloride @ 100ppm at 70 and 90 DAS, B_3: Nipping during 85-95 DAS, B_4: Boron @ 0.1% at 70 and 90 DAS, B_5: Nipping with Boron @ 0.1% at 70 and 90 DAS, B_6: Boron @ 0.1% along with Mepiquat chloride @ 100ppm at 70 and 90 DAS). BG-II (7213-2) was selected for study. Half the dose of nitrogen and potassium, entire dose of phosphorous in the form of urea, muriate of potash (MOP) and diammonium phosphate (DAP), respectively were band placed as per the treatments. Fertilizers were applied 4-5 cm deep and 5 cm away from the plant at 30 days after sowing. Remaining half dose of nitrogen and potassium in the form of urea and MOP was top dressed in two equal splits at 60 and 90 days after sowing in the ring formed 5 cm away from the plant. The soil of the experimental site was deep black and clay in texture with the available nitrogen (204 kg ha^{-1}), phosphorus (34 kg ha^{-1}), potassium (226 kg ha^{-1}), organic carbon content (0.64 %). Sowing was done by dibbling on 11th July, 2016. The mean fibre length and micronaire values were measured by standard methods.

Results and Discussion
Effect of fertilizer levels
Application of 125 per cent RDF recorded significantly higher seed cotton yield (3420 kg ha^{-1}) when compared to 100 per cent RDF (3088 kg ha^{-1}) and 75 per cent RDF (2517 kg ha^{-1}) and is presented in Table 1. It might be due to increased availability of nutrients which helped the plants to attain its maximum yield potential. Application of 125 per cent RDF recorded significantly higher lint index (5.32) compared to 100 per cent RDF (5.02) and 75 per cent RDF (4.52). Quality parameters differed significantly with RDF levels (Table 1 and 2). Ginning percentage, bundle strength (g tex^{-1}) and mean fibre length (mm) were significantly higher with application of 125 per cent RDF (35.50, 28.12 and 25.01, respectively) over 75 RDF (34.19, 27.22 and 24.56, respectively) and it was on par with 100 per cent RDF (35.43, 27.91 and 24.69, respectively). Significantly higher uptake of nitrogen, phosphorus and potassium (154.24, 34.02 and 174.55 kg ha^{-1}, respectively) were recorded with 125 per cent RDF when compared with 100 (138.97, 30.74 and 156.93 kg ha^{-1}) and 75 per cent RDF (114.06, 25.44 and 127.81 kg ha^{-1}, respectively) and is presented in Table 2. These results are in accordance with the findings of Sangh Ravikiran and Halepyati (2013) [8] and Hemlata Chitte *et al.* (2016) [4]. Application of higher levels of fertilizer (125%) recorded significantly higher gross returns (Rs. 1,84,669 ha^{-1}), net returns (Rs. 1,27, 341 ha^{-1}) and benefit cost ratio (3.22) when compared to the application of 100 per cent (Rs. 166776 ha^{-1}, 112015 $ha^{-1}$and 3.04, respectively) and 75 per cent RDF (Rs. 135920 ha^{-1}, 83650 ha^{-1} and 2.60, respectively) (Table 3). The decrease in gross returns, net returns and benefit cost ratios were noticed with decreased levels of fertilize. The higher gross and net returns were mainly due to higher economic yield associated with higher levels of fertilizer applied treatment. These results were in close conformity with reports of Jagvir Singh *et al*. (2012) and Vinayak Hosamani *et al.* (2013) [9].

Table 1: Yield and quality parameters of *Bt* cotton as influenced by macronutrients and morph frame manipulations

Treatments	Seed cotton yield (kg ha^{-1})				Ginning percentage				Lint index				Mean fibre length (mm)			
	F_1	F_2	F_3	Mean	F_1	F_2	F_3	Mean	F_1	F_2	F_3	Mean	F_1	F_2	F_3	Mean
B_1	2337	2689	3088	2705	30.44	33.87	34.16	32.82	3.62	4.51	4.86	4.33	24.43	24.87	25.00	24.77
B_2	2441	3042	3355	2946	34.96	35.53	35.48	35.32	4.58	4.99	5.31	4.96	24.73	25.03	24.97	24.91
B_3	2438	3013	3290	2914	34.39	35.26	35.29	34.98	4.63	5.03	5.29	4.99	24.63	24.80	24.30	24.58
B_4	2420	2978	3283	2894	35.07	35.35	35.56	35.33	4.57	4.91	5.25	4.91	24.83	24.33	25.70	24.96
B_5	2707	3367	3749	3274	34.98	36.24	36.21	35.81	4.80	5.32	5.59	5.24	24.40	24.00	24.60	24.33
B_6	2759	3442	3754	3318	35.27	36.31	36.32	35.97	4.89	5.35	5.61	5.28	24.30	25.10	25.50	24.97
Mean	2517	3088	3420		34.19	35.43	35.50		4.52	5.02	5.32		24.56	24.69	25.01	
	S. Em.±		C.D. at 5%		S. Em.±		C.D. at 5%		S. Em.±		C.D. at 5%		S. Em.±		C.D. at 5%	
F	18		52		0.38		1.08		0.10		0.29		0.13		0.36	
B	25		73		0.53		1.53		0.14		0.41		0.18		NS	
F×B	44		127		0.92		2.64		0.25		0.72		0.31		NS	

NS – Non significant
F_1: 75% RDF
F_2: 100% RDF
F_3: 125% RDF
B_1: Control
B_2: Mepiquat chloride @ 100ppm at 70 and 90 DAS
B_3: Nipping during 85-95 DAS
B_4: Boron @ 0.1% at 70 and 90 DAS
B_5: Nipping + Boron @ 0.1% at 70 and 90 DAS
B_6:Boron @ 0.1% + Mepiquat chloride @ 100ppm at 70 and 90 DAS

Table 2: Bundle strength (g tex^{-1}) and nutrient uptake of *Bt* cotton as influenced by macronutrients and morphoframe manipulations

Treatments	Bundle strength (g tex^{-1})				Nitrogen (kg ha^{-1})				Phosphorus (kg ha^{-1})				Potassium (kg ha^{-1})			
	F_1	F_2	F_3	Mean	F_1	F_2	F_3	Mean	F_1	F_2	F_3	Mean	F_1	F_2	F_3	Mean
B_1	27.03	27.90	28.80	27.91	106.05	121.72	139.48	122.42	23.73	27.08	30.87	27.22	118.24	136.55	157.31	137.36
B_2	27.53	28.80	27.47	27.93	110.68	137.41	151.33	133.14	24.72	30.42	33.40	29.51	123.65	154.88	171.16	149.90
B_3	26.80	27.83	27.13	27.26	110.54	136.15	148.45	131.71	24.69	30.16	32.78	29.21	123.49	153.41	167.79	148.23
B_4	28.13	27.20	29.03	28.12	109.77	134.57	148.16	130.83	24.52	29.82	32.72	29.02	122.59	151.57	167.45	147.20
B_5	27.33	27.03	27.50	27.29	122.51	151.89	168.88	147.76	27.24	33.18	37.14	32.52	138.68	171.81	191.66	167.38
B_6	26.50	28.67	28.80	27.99	124.83	152.10	169.12	148.69	27.74	33.79	37.20	32.91	140.19	173.34	191.95	168.49
Mean	27.22	27.91	28.12		114.06	138.97	154.24		25.44	30.74	34.02		127.81	156.93	174.55	
	S. Em.±		C.D. at 5%		S. Em.±		C.D. at 5%		S. Em.±		C.D. at 5%		S. Em.±		C.D. at 5%	
F	0.24		0.70		0.82		2.35		0.18		0.53		0.93		2.67	
B	0.34		NS		1.16		3.32		0.26		0.74		1.31		3.78	
F×B	0.59		NS		2.00		NS		0.45		NS		2.28		NS	

Table 3: Economics of *Bt* cotton as influenced by macronutrients and morphoframe manipulations

Treatments	Cost of cultivation (Rs./ha)				Gross returns (Rs./ha)				Net returns (Rs./ha)				BC ratio			
	F_1	F_2	F_3	Mean	F_1	F_2	F_3	Mean	F_1	F_2	F_3	Mean	F_1	F_2	F_3	Mean
B_1	51852	54343	56910	54368	126193	145208	166762	146054	74341	90865	109852	91686	2.43	2.67	2.93	2.68
B_2	52088	54579	57146	54604	131817	164245	181147	159069	79729	109666	124001	104465	2.53	3.01	3.17	2.90
B_3	52152	54643	57210	54668	131648	162717	177645	157337	79496	108074	120435	102669	2.52	2.98	3.11	2.87
B_4	52332	54823	57390	54848	130707	160805	177293	156268	78375	105982	119903	101420	2.50	2.93	3.09	2.84
B_5	52632	55123	57690	55148	146169	181822	202435	176809	93537	126699	144745	121661	2.78	3.30	3.51	3.19
B_6	52568	55059	57626	55084	148989	185863	202735	179195	96421	130804	145109	124111	2.83	3.38	3.52	3.24
Mean	52271	54762	57329		135920	166776	184669		83650	112015	127341		2.60	3.04	3.22	
	S. Em.±		C.D. at 5%		S. Em.±		C.D. at 5%		S. Em.±		C.D. at 5%		S. Em.±		C.D. at 5%	
F	-		-		972		2794		972		2794		0.02		0.05	
B	-		-		1375		3951		1375		3951		0.03		0.07	
F×B	-		-		2381		6844		2381		6844		0.04		NS	

NS – Non significant
F_1: 75% RDF B_1: Control B_4: Boron @ 0.1% at 70 and 90 DAS
F_2: 100% RDF B_2: Mepiquat chloride @ 100ppm at 70 and 90 DAS B_5: Nipping + Boron @ 0.1% at 70 and 90 DAS
F_3: 125% RDF B_3: Nipping during 85-95 DAS B_6: Boron @ 0.1% + Mepiquat chloride @ 100ppm at 70 and 90 DAS

Effect of Morpho frame manipulation

Mor pho frame manipulations showed significant effect on yield attributes and quality parameters (Table 1 and 2). Seed cotton yield with foliar spray of mepiquat chloride @ 100ppm along with boron @ 0.1% at 70 and 90 DAS was significantly higher (3318 kg ha^{-1}) and it was on par with foliar spray of boron @ 0.1% at 70 and 90 DAS with nipping during 85-95 DAS (3274 kg ha^{-1}). Significantly lower seed cotton yield was recorded with control (2705 kg ha^{-1}). Higher seed cotton yield is mainly due to the spraying of mepiquat chloride and boron. Mepiquat chloride restricts the vegetative growth of plants and increases the partitioning of assimilates towards fruiting bodies (Amit Kaul, 2013). Boron being a part of enzyme or a catalyst in enzymatic reaction, helps in development of strong cell wall, increase the pollen growth and pollen germination and has effect on square, boll number, flower and boll shedding (Maqshoof *et al*., 2016) [6]. Data of ginning percentage revealed that mepiquat chloride @ 100 ppm along with boron @ 0.1% recorded significantly higher ginning percentage, lint index and bundle strength (35.97, 5.28 and 27.99 g tex^{-1}, respectively) over the control and it was on par with foliar spray of boron @ 0.1% at 70 and 90 DAS with nipping during 85-95 DAS (Table 1 and 2). This is may be due to better translocation and metabolism and also synthesis and accumulation of photosynthates on the building up of efficient photosynthesis structure in the plant by boron. These results similar with findings of Rikhtegar *et al.* (2014) [7].
Among different mor pho frame modification, foliar spray of mepiquat chloride @ 100 ppm along with boron @ 0.1% recorded higher gross returns, net returns and benefit cost ratio (1,79,195 ha^{-1}, 1,24,111 $ha^{-1}$and 3.24, respectively) over the control (1,46,054 ha^{-1}, 91686 $ha^{-1}$and 2.68, respectively).

Interaction effects

In the present investigation, the interaction effect of nutrient levels and morpho frame manipulations were significantly different on seed cotton yield (ha^{-1}), ginning percentage and lint index (Table 1). Application of 125 per RDF with foliar application of mepiquat chloride @ 100 ppm along with boron @ 0.1% at 70 and 90 DAS recorded significantly seed cotton yield per ha (3754 kg), ginning % (36.32) and lint index (5.61) over the 75 per cent RDF with control (2337kg, 30.44 and 3.62, respectively) and it was on par with the application of 125 per RDF with foliar spray of boron @ 0.1% at 70 and 90 DAS with nipping during 85-95 DAS (3749 kg, 36.21 and 5.59, respectively). Application of 125 per cent RDF with foliar spray of mepiquat chloride @ 100 ppm along with boron @ 0.1% noticed higher gross returns (2,02,735 ha^{-1}) and net returns (1,45,109 ha^{-1}) over the 75 per cent RDF with control (1,26,193 ha^{-1} and 74341 ha^{-1}, respectively) and is presented in Table 3.
It was concluded that, application of 125 per RDF with foliar application of mepiquat chloride @ 100 ppm along with boron @ 0.1% at 70 and 90 DAS recorded significantly higher seed cotton yield, gross returns and net returns compared to other treatment combinations which was on par with 125 per RDF with foliar spray of boron @ 0.1% at 70 and 90 DAS with nipping during 85-95 DAS.

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