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Nutrient uptake and physico-chemical properties of soil as influenced by Bt cotton (*Gossypium hirsutum* L.) based cropping systems under different spacings

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ABSTRACT : A field experiment was conducted on loamy sand soils of Agronomy Instructional Farm, C.P. College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar during the years 2012-13 and 2013-14 to study the cropping systems and spacing on performance of Bt cotton. The soil of the experimental plot was low in organic carbon and available nitrogen, medium in available phosphorus and potash. The experiment was laid out in Split Plot Design with four replications. Twelve treatment combinations comprised of three spacing treatments *viz.*, 120 x 45 cm, 150 x 45 cm, 180 x 45 cm were taken in the main plots and four cropping system treatments *viz.*, sole Bt cotton, Bt cotton + greengram -*Rabi* castor, Bt cotton + cowpea -*Rabi* castor and Bt cotton + sesamum -*Rabi* castor in the sub-plots. Spacing of 120 x 45 cm found significantly superior by recording higher seed cotton yield. Seed cotton yield was also higher under sole Bt cotton as compared to other cropping systems. Closer spacing of 120 x 45 cm proved its superiority by recording higher total nitrogen, phosphorus and potash uptake. Bt cotton + cowpea-*Rabi* castor cropping system was found significantly superior and recorded higher available nitrogen and available potassium, organic carbon and bulk density at end of cropping system. The cropping system Bt cotton + sesamum – *Rabi* castor proved its superiority by recording significantly higher available phosphorus at the end of the cropping system. Cropping system Bt cotton + cowpea – *Rabi* castor was found significantly superior by recording higher total nitrogen, phosphorus and potash uptake. Treatment combination S_1C_2 (120 x 45 cm spacing + Bt cotton + greengram- *Rabi* castor) obtained significantly higher P uptake.

KEY **W**ORDS : Nutrient uptake, Cropping systems, Spacing physico-chemical properties, Yield

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Cotton as a crop as well as a commodity plays an important role in the agrarian and industrial activities of the nation and has a unique place in the economy of our country. Cotton, popularly known as "white gold" is grown mainly for fibre. In addition to this, cotton seed is the second important source

of the edible oil. India has been a traditional home of cotton and their textiles. Cotton also known as "king of the fibre" supports millions of people, directly or indirectly by providing huge employment through cultivation, processing and its trade. In India, cotton is planted in 11.5 million hectares of land and it occupies second position with production of 375 lakh bales (each of 170 kg) after China among all cotton producing countries in the world (COTCORP, 2014). Conventional method of planting of cotton with closely spaced rows does not permit the intercropping and relay cropping between rows of cotton. Because inter and relay crop required more space especially in *Rabi* castor. Pattern of cotton planting in widely spaced row not only gives seed cotton yield comparable with that of the conventional method of planting but also facilitates intercropping and relay cropping. Widely spaced rows of cotton have scope to grow intercrops between two rows as it have enough space for growth and development of inter and relay crops. Intercrops complete their life cycle in short duration. So, it also gives a change to take a relay crop as *Rabi* castor on the place of intercrops. The main concept of intercropping is to get increased productivity per unit land area and time, and also equitable and judicious utilization of land resources and farming inputs including labour. Though intercrops reduced seed cotton yield by 8-31 per cent, yet total crop productivity and net return per unit area were higher in intercropping than sole cropping (Mohammed *et al.*, 1994).

RESEARCH PROCEDURE

The field experiment was carried out during *Kharif* 2012-13 to *Rabi* 2013-14 at Agronomy Instructional Farm, C.P. College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar (Gujarat). The experiment was conducted in Split Plot Design with four replications. Three spacing *viz.*, 120 x 45 cm; 150 x 45 cm; 180 x 45 cm were taken in the main plots with combinations of four cropping system *viz.*, sole Bt cotton; Bt cotton + greengram - *Rabi* castor; Bt cotton + cowpea - *Rabi* castor and Bt cotton + sesamum - *Rabi* castor were in the sub-plots. The soil of the experimental site was loamy sand (83.9 % sand; 5.5 % silt and 9.8 % clay) having pH 7.3; low in organic carbon (0.20%), EC (0.12 dS/m), bulk density (1.63 Mg/m^3), particle density (2.78 Mg/m^3), available N (171 kg/ha), medium in available P (39 kg/ha) and K (273 kg/ha). Bt cotton (Boll guard II) 'Vikram 5' was sown by dibbling at 120 x 45 cm; 150 x 45 cm; 180 x 45 cm spacings on 20 June in 2012 and on 23 June in 2013. One, two and three rows of different intercrops were sown in additive series between two rows of Bt cotton at 60 cm spacing on same date of Bt cotton. In Bt cotton 200 kg N/ha was applied in split doses. Half dose of nitrogen was applied at seedling and remaining N in two equal doses side dressed at flowering and boll formation stages. P 40 kg/ha and 20 kg S/ha were applied at seedling time as per recommended doses. Systemic insecticide was applied for control of sucking pest on Bt cotton.

RESEARCH ANALYSIS AND REASONING

The findings of the present study as well as relevant discussion have been presented under following heads :

Yield of Bt cotton :

Effect of spacing on Bt cotton :

Spacing significantly altered the seed cotton yield (kg/ha) as indicated in Table 4. On an average, closer spacing of 120 x 45 cm produced significantly higher seed cotton yield (3276 kg/ha). The magnitude of increase in seed cotton yield was to the tune of 5.7 and 30.3 per cent over 150 x 45 cm and 180 x 45 cm spacing, respectively. It was mainly due to high plant population accommodated per unit area with closer spacing than wider spacing. Similar findings were also reported by Solanke *et al*. (2001); Tomar *et al*. (2002); Katore *et al*. (2006) and Shukla *et al*. (2013).

Effect of cropping systems on Bt cotton :

An appraisal of data furnished in Table 4 indicated that cropping system influenced seed cotton yield significantly. Sole Bt cotton produced higher seed cotton yield (3114 kg/ha) as compared to other cropping systems. The magnitude of increase in seed yield was to the extent of 4.6, 8.0 and 8.2 per cent over Bt cotton + sesamum – *Rabi* castor, Bt cotton + greengram – *Rabi* castor and Bt cotton + cowpea – *Rabi* castor, respectively. The higher seed cotton yield of Bt cotton in sole cropping might be due to lesser competition for space, sunlight, water and nutrients between Bt cotton and component crops which gave higher growth parameters resulting in higher translocation of photosynthates from source to sink resulted in higher yield of Bt cotton. A similar trend was observed by Naganagouda *et al*. (2001); Ganajaxi *et al*. (2011) and Satish *et al*. (2012).

Soil status after harvest of crops and N, P and K uptake :

Effect of spacing on Bt cotton :

There was an increase in the N, P_2O_5, K_2O, OC and porosity and decrease in EC, pH, particle density and bulk density at the end of the cropping systems compared to before the experiment as depicted in Table 1 to 3. Available nitrogen, phosphorus, potassium, organic carbon, EC, pH, particle density, bulk density as well as porosity were found to be non significant among different spacing treatments tried in experiments. There seems to be a correlation in the amount of biomass produced and the nutrient uptake by the various crops. Table 5 designates that closer spacing of 120 x 45 cm proved its superiority by recording significantly higher total NPK uptake. The higher uptake of NPK in this treatment might be due to higher biological yield produced under 120 x 45 cm spacing. Similar results were noticed by Ravankar and Lehria (1994) and Shukla *et al*. (2012).

Effect of cropping system on Bt cotton :

Available N, P_2O_5, K_2O, organic carbon, EC, pH, particle density, bulk density and porosity recorded at the end of the cropping systems and illustrated in Table 1 to 3.

Bt cotton + cowpea – *Rabi* castor cropping system was found significantly superior and recorded higher available nitrogen (195.5 kg/ha) and available potassium (283.6 kg/ha) at end of cropping system. This might be attributed to the supplementation of nitrogen synthesized in the root nodules of cowpea by the process of symbiotic nitrogen fixation and added soil organic matter in Bt. cotton + cowpea – *Rabi* castor. Thereby, resulted in the additive enrichment and enhanced soil fertility. These findings corroborate the results by Sepat *et al*. (2012). He also observed that inclusion of pulses in cropping systems resulted in better physico – chemical status of soil.

The cropping system Bt cotton + sesamum – *Rabi* castor proved its superiority by recording significantly higher available phosphorus 44.46 kg/ha at the end of the cropping system. This might be due to secretion of acid by sesamum which solubilises initial pool of P in the soil. Organic carbon was found significantly higher 0.30 per cent in Bt cotton + cowpea – *Rabi* castor cropping system. The abundant leaf fall and deep root system of cotton and castor promote the conversion of plant

Table 1: Soil fertility status at the end of the cropping system as influenced by different treatments

Treatments	Soil fertility status at the end of cropping systems								
	Available N (kg/ha)			Available P_2O_5 (kg/ha)			Available K_2O (kg/ha)		
	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled
Spacing									
S_1 : 120 cm x 45 cm	179.4	182.2	180.8	42.08	42.74	42.41	277.7	276.2	276.9
S_2 : 150 cm x 45 cm	183.6	188.3	185.9	43.50	43.86	43.68	279.3	277.4	278.3
S_3 : 180 cm x 45 cm	185.7	190.1	187.9	43.70	44.12	43.91	279.6	279.2	279.4
S.E. ±	3.8	3.8	2.7	0.80	0.65	0.51	4.2	5.3	3.4
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS
C. V. %	8.3	8.1	8.2	7.43	5.93	6.71	6.01	7.57	6.83
Cropping systems									
C_1 : Sole Bt cotton	174.6	175.1	174.9	40.43	40.73	40.58	272.1	268.3	270.2
C_2 : Bt cotton + green gram – *Rabi* castor (120 cm between plant)	188.4	195.0	191.7	43.67	44.47	44.07	281.1	279.9	280.5
C_3 : Bt cotton + cowpea – *Rabi* castor (120 cm between plant)	192.1	199.0	195.5	43.95	44.50	44.23	284.2	283.0	283.6
C_4 : Bt cotton + sesamum– *Rabi* castor (120 cm between plant)	176.5	178.3	177.4	44.32	44.61	44.46	278.0	279.2	278.6
S.E. ±	3.3	3.1	2.2	0.97	0.44	0.53	3.5	2.2	2.1
C.D. (P=0.05)	9.6	8.9	6.4	2.81	1.27	1.51	10.1	6.5	5.8
Interaction									
S x C	NS	NS	NS	NS	NS	NS	NS	NS	NS
C. V. %	5.4	4.9	5.2	6.7	3.0	5.2	3.7	2.4	2.4

NS= Non-significant

Table 2 : Organic carbon, EC and pH at the end of the cropping system as influenced by different treatments

Treatments	Soil physico-chemical status at the end of cropping system								
	Organic carbon (%)			EC (dS/m)			pH		
	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled
Spacing									
S_1 : 120 cm x 45 cm	0.27	0.29	0.28	0.11	0.10	0.10	7.22	7.20	7.21
S_2 : 150 cm x 45 cm	0.26	0.28	0.27	0.10	0.10	0.10	7.21	7.19	7.20
S_3 : 180 cm x 45 cm	0.26	0.28	0.27	0.10	0.10	0.10	7.20	7.18	7.19
S.E.±	0.01	0.01	0.01	0.00	0.00	0.00	0.07	0.12	0.07
C. D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS
C. V. %	14.84	15.34	15.12	7.62	14.31	11.40	3.88	6.86	5.57
Cropping systems									
C_1 : Sole Bt cotton	0.22	0.25	0.24	0.10	0.10	0.10	7.27	7.25	7.26
C_2 : Bt cotton + green gram – *Rabi* castor (120 cm between plant)	0.29	0.32	0.30	0.11	0.11	0.11	7.19	7.17	7.18
C_3 : Bt cotton + cowpea – *Rabi* castor (120 cm between plant)	0.30	0.31	0.30	0.11	0.11	0.11	7.17	7.15	7.16
C_4 : Bt cotton + sesamum– *Rabi* castor (120 cm between plant)	0.25	0.26	0.25	0.11	0.10	0.10	7.19	7.17	7.18
S.E. ±	0.01	0.01	0.01	0.00	0.00	0.00	0.08	0.06	0.05
C. D. (P=0.05)	0.03	0.03	0.02	NS	NS	NS	NS	NS	NS
Interaction									
S x C	NS	NS	NS	NS	NS	NS	NS	NS	NS
C. V. %	12.08	12.05	12.07	7.02	12.36	10.00	3.40	2.71	3.08

NS= Non-signifncant

Table 3: Particle density, bulk density and porosity at the end of the cropping systems as influenced by different treatments

Treatments	Soil physical property at the end of cropping systems								
	Particle density (g /cc)			Bulk density (g/cc)			Porosity (%)		
	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled
Spacing									
S_1 : 120 cm x 45 cm	2.70	2.69	2.69	1.54	1.53	1.54	42.5	42.7	42.6
S_2 : 150 cm x 45 cm	2.75	2.75	2.75	1.55	1.53	1.54	43.4	44.3	43.9
S_3 : 180 cm x 45 cm	2.77	2.76	2.77	1.58	1.55	1.56	42.8	43.7	43.3
S.E. ±	0.05	0.05	0.04	0.03	0.03	0.02	1.9	2.0	1.4
C. D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS
C. V. %	7.31	7.19	7.25	7.28	8.07	7.68	18.0	18.7	18.4
Cropping systems									
C_1 : Sole Bt cotton	2.76	2.73	2.74	1.59	1.59	1.59	42.0	41.7	41.8
C_2 : Bt cotton + green gram – *Rabi* castor (120 cm between plant)	2.74	2.73	2.73	1.52	1.50	1.51	43.9	44.8	44.3
C_3 : Bt cotton + cowpea – *Rabi* castor (120 cm between plant)	2.72	2.74	2.73	1.52	1.49	1.51	44.0	45.4	44.7
C_4 : Bt cotton + sesamum– *Rabi* castor (120 cm between plant)	2.74	2.74	2.74	1.59	1.57	1.58	41.8	42.4	42.1
S.E. ±	0.06	0.06	0.04	0.02	0.03	0.02	1.7	1.6	1.2
C.D. (P=0.05)	NS	NS	NS	0.07	0.08	0.05	NS	NS	NS
Interaction									
S x C	NS	NS	NS	NS	NS	NS	NS	NS	NS
C. V. %	6.65	6.54	6.60	4.43	5.48	4.98	12.2	11.1	11.6

NS= Non-significant

Table 4 : Seed cotton yield of Bt cotton as influenced by different treatments

Treatments	Seed cotton yield (kg/ha)		
	2012-13	2013-14	Pooled
Spacing			
S_1 : 120 cm x 45 cm	3239	3313	3276
S_2 : 150 cm x 45 cm	3048	3153	3101
S_3 : 180 cm x 45 cm	2479	2550	2514
S.E. ±	94	91	65
C. D.(P=0.05)	326	314	201
C. V. %	12.9	12.1	12.5
Cropping systems			
C_1 : Sole Bt cotton	3080	3148	3114
C_2 : Bt cotton + greengram – *Rabi* castor (120 cm between plant)	2818	2949	2884
C_3 : Bt cotton + cowpea – *Rabi* castor (120 cm between plant)	2844	2915	2879
C_4 : Bt cotton + sesamum– *Rabi* castor (120 cm between plant)	2946	3008	2977
S.E. ±	80	61	50
C. D. (P=0.05)	232	176	142
Interaction			
S x C	NS	NS	NS
C. V. %	8.2	6.1	7.2

NS= Non-significant

Table 5 : Total nutrients uptake as influenced by different treatments

Treatments	Total nutrients uptake								
	N uptake (kg/ha)			P uptake (kg/ha)			K uptake (kg/ha)		
	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled
Spacing									
S_1 : 120 cm x 45 cm	174.4	180.9	177.6	44.6	46.9	45.7	107.1	111.7	109.4
S_2 : 150 cm x 45 cm	172.8	174.3	173.6	43.2	42.5	42.9	101.0	105.7	103.3
S_3 : 180 cm x 45 cm	156.2	163.5	159.9	40.2	41.4	40.8	90.7	95.0	92.8
S.E. ±	4.0	3.9	2.8	1.0	1.0	0.7	2.6	2.7	1.9
C. D. (P=0.05)	14.0	13.3	8.6	3.3	3.6	2.2	9.0	9.2	5.7
C. V. %	9.6	8.9	9.3	9.0	9.5	9.2	10.4	10.2	10.3
Cropping systems									
C_1 : Sole Bt cotton	87.7	82.4	85.0	21.4	21.7	21.6	43.1	44.5	43.8
C_2 : Bt cotton + green gram – *Rabi* castor (120 cm between plant)	201.8	208.5	205.2	49.9	50.8	50.4	120.6	125.8	123.2
C_3 : Bt cotton + cowpea – *Rabi* castor (120 cm between plant)	207.7	216.4	212.1	51.2	52.6	51.9	122.6	128.2	125.4
C_4 : Bt cotton + sesamum– *Rabi* castor (120 cm between plant)	174.0	184.3	179.2	48.2	49.1	48.7	112.1	117.8	115.0
S.E. ±	5.0	4.6	3.4	1.1	0.9	0.7	2.1	3.2	1.9
C.D. (P=0.05)	14.4	13.3	9.6	3.3	2.6	2.1	6.2	9.4	5.5
Interaction									
S x C	NS	NS	NS	NS	Sig.	NS	NS	NS	NS
C. V. %	8.9	7.9	8.4	8.1	6.2	7.2	6.4	9.3	8.1

NS= Non-significant

Table 6 : Interaction effect of spacing and cropping systems on P uptake (kg/ha)

	2012-13		
	S_1	S_2	S_3
C_1	23.1	22.4	19.7
C_2	56.5	50.7	45.3
C_3	55.9	49.7	52.4
C_4	52.0	47.2	48.2
S.E. ±		1.3	
C.D. (P=0.05)		3.9	
C. V. %		6.2	

sequestered carbon to soil organic carbon, thus, responsible for increased organic carbon content in the soil. The result showed that there was a build up of organic carbon by 50 per cent higher than initiation of the experiment. These findings are in close agreement with those of Sepat *et al*. (2012).

EC, pH and particle density were found to be non-significant among cropping system treatments tried in experiment. Bulk density was found significantly lower in Bt cotton + cowpea – *Rabi* castor 1.51 Mg/m^3. This might be due to higher organic carbon recorded in this treatment which increased porosity resulted in lower bulk density. Cropping system Bt cotton + cowpea – *Rabi* castor was found significantly superior by recording higher total NPK uptake. The higher uptake of NPK in this treatment might be due to higher biological yield which is responsible for higher uptake of NPK nutrients.

Interaction effect :

Phosphorus uptake :

Interaction between spacing and cropping systems (S x C) was found to be significant with respect to phosphorus uptake during 2013-14 (Table 6).

From the interaction data (Table 6), it is revealed that treatment combination S_1C_2 (120 x 45 cm spacing + Bt cotton + greengram – *Rabi* castor) obtained significantly higher P uptake during year 2013-14 which was at par with S_1C_3 (120 x 45 cm spacing + Bt cotton + cowpea – *Rabi* castor. Which was highly taken up by these crops resulted in high nutrients content may be another reason of high uptake of nutrients.

LITERATURE CITED

Ganajaxi, S. I. H., Hiremath, S. M. and Chittapur, B. M. (2011). Production of Bt and non-Bt cotton and French bean intercropping system in northern transition zone of Karnataka. *Indian J. Agron.,* **56** (2) : 92-97.

Katore, J.R., Wankhade, S.T., Chavan, A.K., Sajid, M. and Tiwari, V.A. (2006). Effect of spacing and fertilizer levels on soil moisture studies and economics in hirsutum cotton hybrids. *Crop Protec. & Produ.*, **1**:26-27.

Mohammad, M. K., El-din, G. M.S. and Hosny, A. A. (1994). Evaluating three patterns of intercropping cotton and forage cowpeas. *Ann. Agric. Sci. Moshtohor,* **29**: 1269–84.

Naganagouda, R., Veeranna, V. S., Guled, M.B. and Hiremath, S. M. (2001). Effect of modified planting geometry on desi cotton intercropping with oilseeds. *Karnataka J. Agric. Sci.*, **14**(4) : 1056-1058.

Ravankar, H.N. and Lehria, G.S. (1994). Response of cotton varieties to levels of nitrogen under different plant population. *Dr. Panjabrao Deshmukh Krishi Vidyapeeth Res. J.*, **18** : 104-105.

Satish, P., Raja, V., Mohammad, S. and Sailaja, V. (2012). Effect of intercropping on growth and seed cotton yield of Bt cotton with different planting patterns. *J. Res. Acharya N.G. Ranga Agric. Univ.*, **40**(1):21-25.

Sepat, S., Ahlawat, I.P.S. and Rana, D.S. (2012). Effect of phosphorus sources and levels on Bt-cotton (*Gossypium hirsutum*) based intercropping systems. *Indian J. Agron.*, **57** (3) : 235-240.

Shukla, U. N., Khakare, M.S., Srivastava, V. K., Kumar, R., Singh, S., Kumar, V. and Kumar, K. (2012). Effect of spacings and fertility levels on growth, yield and quality of cotton hybrids under rainfed condition of Vidarbha. *Bioscan,* **8** (2) : 561-567.

Shukla, U.N., Khakare, M.S., Bhale, V.M. and Singh, S. (2013). Plant population, nutrient uptake and yield of cotton (*Gossypium hirsutum*) hybrids as affected by spacing and fertility levels under rainfed condition. *Indian J. Agric. Res.*, **47**(1): 83 – 88.

Solanke, V. M., Turkhede, A.B., Katkar, R.N., Wankhade, S.T.

and Sakhare, B.A. (2001). Response of cotton hybrids to various agronomic practices. *Crop Res.*, **21**:30-33.

Tomar, R.S.S., Kushwaha, A.L. and Pandey, S.C. (2002). Effect of row and intra row spacing on yield and quality of hybrid cotton (*G. hirsutum*) under rainfed condition. *J. Cotton Res. & Develop.*, **16**:24-26.

WEBLIOGRAPHY

The Cotton Corporation of India Ltd. (2014). COTCORP, Agriculture data. Available at *www.http://cotcorp.gov.in/statistics.aspx.*