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Effect of Integrated Nutrient Management on Bt Cotton and Post Harvest Soil Fertility under Dry Farming Agriculture

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ABSTRACT

The present study pertains to the effect of Integrated Nutrient Management (INM) techniques on seed cotton yield, economics and soil physico-chemical properties under rainfed condition. The 10 different treatments combinations comprising of organic and inorganic fertilizers (NPK), gypsum, castor cake, compost and vermi-compost were studied. The experimental result showed that the significantly highest seed cotton yield and highest net return were recorded under treatment T_9 (80 kg ha^{-1} + 10 t compost ha^{-1} +500 kg castor cake ha^{-1}+ bio-fertilizer-Azotobacter+ PSM). The effect of different treatments on EC, organic carbon, available phosphorus and potash and sulphur status in the soil were found significant and the maximum availability of most of the micronutrients were recorded on account of application of compost at 10 t ha^{-1} + vermi compost at 1 t ha^{-1} + castor cake at 500 kg ha^{-1} + bio-fertilizer (*Azotobacter*+PSM). Bulk density of soil was found to reduced due to application of organic alone (i.e., compost at 10 t ha^{-1}, compost at 10 t ha^{-1} +vermi compost at 1 t ha^{-1} + castor cake at 500 kg ha^{-1} + bio-fertilizer (*Azotobacter*+PSM) or integration of organic and inorganic sources of nutrient (N at 80 kg ha^{-1} +castor cake 500 at kg ha^{-1} and N at 80 kg ha^{-1} +compost at 10 t ha^{-1} +castor cake at 500 kg ha^{-1} +bio-fertilizer.

Key words: *Azotobacter*, vermiculture, micronutrient, bio-fertilizer, soil properties

INTRODUCTION

Cotton 'the king of apparel fibers' is an important cash crop and it supplies a major share of raw material for the textile industry and playing a key role in the economic and social affairs of the world (Anonymous, 2010; Hosamani *et al*., 2013). It is grown chiefly for its fibre which is used in the manufacture of cloths, making of threads and extraction of oil from cotton seed (Deshmukh *et al*., 2013). The cotton (*Gossypium hirsutum* L.), an important fibre crop, is grown throughout India under both rainfed and irrigated conditions on an area of 9.5 million ha (Mayee *et al*., 2008; Yang *et al*., 2014). India ranks first in area and production is far below the world average of over 600 kg ha^{-1} (Gadhiya *et al*., 2009).

The cultivation of cotton is increasing day by day in North Saurashtra Agro-climatic zone due to change in rainfall pattern, sustained price at higher level, demand for export and introduction of pest resistant variety. Nitrogen, phosphorus and potassium are primary element to increase of agricultural crop production. Among these, nitrogen is one of the decisive as well as expensive inputs, which has quickest and most pronounced effect on plant growth. As a constituent of

protoplasm, it is intimately involved in the process of photosynthesis and ultimately, in the dry matter production. The organic manures plays an important role in crop production (Usman *et al*., 2013). It acts on the soil physical properties, organic matter promotes formation of soil crumbs, thus makes the soil friable and the thereby facilitates the proper movement of air and water as well as absorption of rain water. It also adds plant nutrients to the soil during organic matter decomposition which act on the insoluble nutrients reserve in the soil and make them available biologically as it provides food for the beneficial soil microorganisms. At present acute problems of reddening of cotton are observed (Das *et al*., 2004). Keeping in view, the experiment was planned to study the effect of integrated nutrient management in Bt cotton for sustaining yield and soil fertility under dry farming conditions.

MATERIALS AND METHODS

The experiment was carried out on rainfed Bt cotton during kharif seasons of 2008-2013 at Dry Farming Research Station, Junagadh Agricultural University, Targhadia (Dist: Rajkot, Gujarat, India). The physical characteristics of soil were measured viz. field capacity (34.52%), wilting point (17.26%), apparent specific gravity. (1.38%), infiltration rate (10.15 mm h^{-1}), maximum WHC (59.05) and soil texture (clayey). The chemical characteristics of soil were also measured according to soil depth. The soil characteristics of depth (0-15 cm) had pH (1:25): 8, Electrical Conductivity (EC): 0.19 m mhos cm^{-1}, Organic Carbon (OC): 0.493%, available P_2O_5: 20.3 kg ha^{-1} and available K_2O: 346 kg ha^{-1}. The soil characteristics of depth (15-30 cm) had pH (1:25): 8.15, Electrical Conductivity (EC): 0.19 m mhos cm^{-1}, Organic Carbon (OC): 0.42%, Available P_2O_5: 8.1 kg ha^{-1} and available K_2O: 346 kg ha^{-1}. The experiment included total 10 treatments viz. T_1 (Absolute control), T_2 (10 t compost ha^{-1}), T_3 (80 kg N ha^{-1}), T_4 (80 kg N ha^{-1} + 40 kg P_2O_5 ha^{-1}), T_5 (80 kg N ha^{-1} +40 kg K_2O ha^{-1}), T_6 (80 kg N ha^{-1} +40 kg P_2O_5 ha^{-1} +40 kg K_2O ha^{-1}), T_7 (80 kg N ha^{-1} +40 kg P_2O_5 ha^{-1} +250 kg gypsum ha^{-1}), T_8 (80 kg N ha^{-1} + 500 kg castor cake ha^{-1}), T_9 [80 kg N ha^{-1} +10 t compost ha^{-1} + 500 kg castor cake ha^{-1} + bio-fertilizer (*Azotobacter*+PSM)] and T_{10} [10 t compost ha^{-1} +1 t vermi compost ha^{-1}+500 kg castor cake ha^{-1}+ bio-fertilizer (*Azotobacter*+PSM)], each replicates thrice in random block design with the plot size of (a) Gross: 5.4×4.5 m (b) Net: 3.6×2.7 m. The spacing and seed rate were 90×30 cm and 1.250 kg ha^{-1}, respectively. The fertilizer was given as per treatments. The 80 kg N ha^{-1} was applied in three splits as 20 kg N ha^{-1} as basal, 40 kg N ha^{-1} as top dressing at 35-40 days and 20 kg N ha^{-1} as top dressing at 60-65 days after sowing.

RESULTS AND DISCUSSION

Seed cotton yield: The result revealed that seed cotton yield was significantly affected due to different treatments during all the years and pooled results (Table 1 and 2). Significantly highest seed cotton yield was recorded under T_9 (80 kg ha^{-1}+ 10 t compost ha^{-1} +500 kg castor cake ha^{-1}+bio-fertilizer (*Azotobacter*+PSM) in the individual year and also in pooled as compared to remaining treatments but it was at par with T_8, T_7, T_6, T_5, T_4 and T_3. The highest seed cotton yield resulted in treatment T_9 (80 kg ha^{-1}+10 t compost ha^{-1}+500 kg castor cake ha^{-1} + bio-fertilizer (*Azotobacter*+PSM) on account of balance supply of nutrients through organic and inorganic sources which improve physical and chemical properties of soil. Hence, combined use of organic with inorganic fertilizers has considerable importance as to take remedial measures in fertility

Table 1: Rainfall distribution during experimentation period

	2009-10		2010-11		2011-12		2012-13		2013-14	
Std. week No.	Rainfall (mm)	Rainy days	Rainfall (mm)	Rainy days	Rainfall (mm)	Rainy days	Rainfall (mm)	Rainy days	Rainfall (mm)	Rainy days
May-June										
19	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
20	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
21	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
22	0.0	0	29.0	2	0.0	0	0.0	0	0.0	0
June-July										
23	0.0	0	60.0	2	0.0	0	0.0	0	16.4	2
24	0.0	0	11.6	2	18.1	1	96.7	2	93.1	3
25	12.0	1	62.0	1	0.0	0	0.0	0	43.4	1
26	2.8	0	0.0	0	0.0	0	0.0	0	0.0	0
July-Aug.										
27	30.1	3	102.8	4	64.0	2	20.2	2	12.0	2
28	25.0	3	20.0	2	238.0	3	23.4	2	111.8	4
29	176.8	5	92.9	6	242.0	3	1.8	0	11.9	2
30	109.0	4	163.3	6	31.3	2	0.0	0	37.2	2
31	0.0	0	164.3	3	70.6	2	0.0	0	42.8	4
Aug.-Sep.										
32	0.0	0	55.3	3	100.6	2	0.0	0	51.0	3
33	0.0	0	42.5	3	58.8	3	4.0	1	45.7	3
34	0.0	0	19.2	2	12.2	2	10.9	2	5.0	1
35	102.5	1	201.5	6	99.6	4	63.8	4	0.0	0
Sept.										
36	0.0	0	30.0	4	104.4	3	100.3	4	12.1	1
37	0.0	0	85.1	4	78.0	3	78.3	3	30.0	2
38	0.0	0	0.0	0	8.3	2	5.1	1	43.0	1
39	0.0	0	2.0	0	19.0	1	0.0	0	445.4	4
Oct.-Nov.										
40	0.0	0	0.0	0	0.0	0	0.0	0	20.4	1
41	0.0	0	0.0	0	0.0	0	0.0	0	80.2	2
42	0.0	0	8.6	1	0.0	0	0.0	0	0.0	0
43	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
44	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Nov.-Dec.										
45	0.0	0	21.0	1	0.0	0	0.0	0	0.0	0
46	0.0	0	16.8	1	0.0	0	0.0	0	0.0	0
47	0.0	0	23.7	2	0.0	0	0.0	0	0.0	0
48	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0
Total	458.2	17	1144.5	46	1044.31	33	404.5	21	1101.4	38

Table 2: Effect of integrated nutrient management on seed cotton yield (kg ha^{-1})

Treatments	2009-10	2010-11	2011-12	2012-13	2013-14	Pooled
T1	742	1238	969	1344	1543	1138
T2	1103	1303	1245	2449	2846	1638
T3	1056	1975	1913	2370	2949	1924
T4	1043	2164	2067	2202	3189	2067
T5	1135	2016	2112	2229	3121	2079
T6	1171	2123	1885	2164	3292	2109
T7	1272	2219	1877	2366	3326	2136
T8	1169	2109	1878	2222	3155	2043
T9	1245	2160	2327	2751	4047	2298
T10	1103	1368	1338	2503	3018	1712
M±S.E	87	126	87	196	344	138
CD at 5 (%)	259	375	259	581	1023	396
CV (%)	13.69	11.69	8.57	14.98	14.06	15.82
Y			**YXT**			
M±S.E	98		M±S.E.	175		
CD at 5 (%)	280		CD at 5%	492		

CV: Coefficient of variation, M±S.E: Standard error of the mean

Table 3: Effect of integrated nutrient management on yield attributes of cotton

Treatments	Plant height (cm)/plant	No. of branches/plant	No. of balls/plant
T1	85	9.37	10.47
T2	92	10.95	12.00
T3	96	10.71	13.17
T4	100	11.40	14.57
T5	101	11.33	14.65
T6	102	11.67	15.08
T7	104	11.95	15.31
T8	101	11.72	14.75
T9	108	12.23	17.35
T10	95	11.11	13.17
M±S.E	2.71	0.38	1.05
CD at 5%	7.77	1.09	3.01
CV (%)	6.32	6.77	16.02
Y			
M±S.E	1.91	0.27	0.74
CD at 5%	5.49	0.77	2.13
YXT			
M±S.E	3.59	0.44	1.30
CD at 5%	10.10	1.24	3.66

M: Mean, SE: Standard error, CV: Coefficient of variation, M±S.E: Standard error of the mean

management and boosting the production. Similar result were found by various researchers, demonstrated the positive outcomes of integrated nutrient management in many areas (Laekemariam and Gidago, 2012; Islam *et al*., 2014).

Growth parameters/yield attributes: The results (Table 3) revealed that the effect of integrated nutrient management on number of branches plant^{-1}, number of balls plant^{-1} and plant height (cm) was found significant. The highest number of branches/plant, numbers of balls plant^{-1} and plant height (cm) were recorded under treatment T_9. These happen because crop got nutrients and moisture for longer period of time due to of application nutrients through organic and inorganic sources. Sridevi and Ramakrishnan (2010) also found similar results in combination of NPK fertilizer and fungi. The plant population ha^{-1} was found non significant.

Post harvest soil fertility: The results of post harvest soil fertility are showing in Fig. 1 and Table 4. The results revealed that organic carbon (Fig. 1c), available phosphorus (Fig. 1c), potash (Fig. 1e) and sulphur status (Fig. 1e) in the soil were significantly differed under different treatments and varied from 0.457-0.575%, 20.2-39.5 kg ha^{-1}, 354-402 kg ha^{-1}and 12.1-20.6 ppm, respectively. The maximum and minimum availability of most of the nutrients were maintained under T10 and T1, respectively. In case of micronutrients, availability of Fe, Zn and Mn (Fig. 1d) were significantly differed under different treatments (Salem and El-Gizawy, 2012; Rathod *et al*., 2012). The highest availability was recorded with application of treatment T_{10} [10 t compost ha^{-1}+1 t vermi compost ha^{-1}+ 500 kg castor cake ha^{-1}+ bio-fertilizer (*Azotobacter*+PSM)].

The results (Fig. 1a-b) revealed that bulk density, water holding capacity, downward movement of water and infiltration rate were differed significantly under different treatments under integrated of nutrient management. Bulk density of soil was found to reduced due to alone or integration organic and inorganic sources of nutrient. Similar, beneficial effect of integration of organic and inorganic sources of nutrient was also observed on water holding capacity, % expansion by weight, downward movement of water and infiltration rate.

Economics: Economic response of cotton to integrated fertilizer management was worked out on the basis of pooled result and presented in Table 5. The data indicated that application

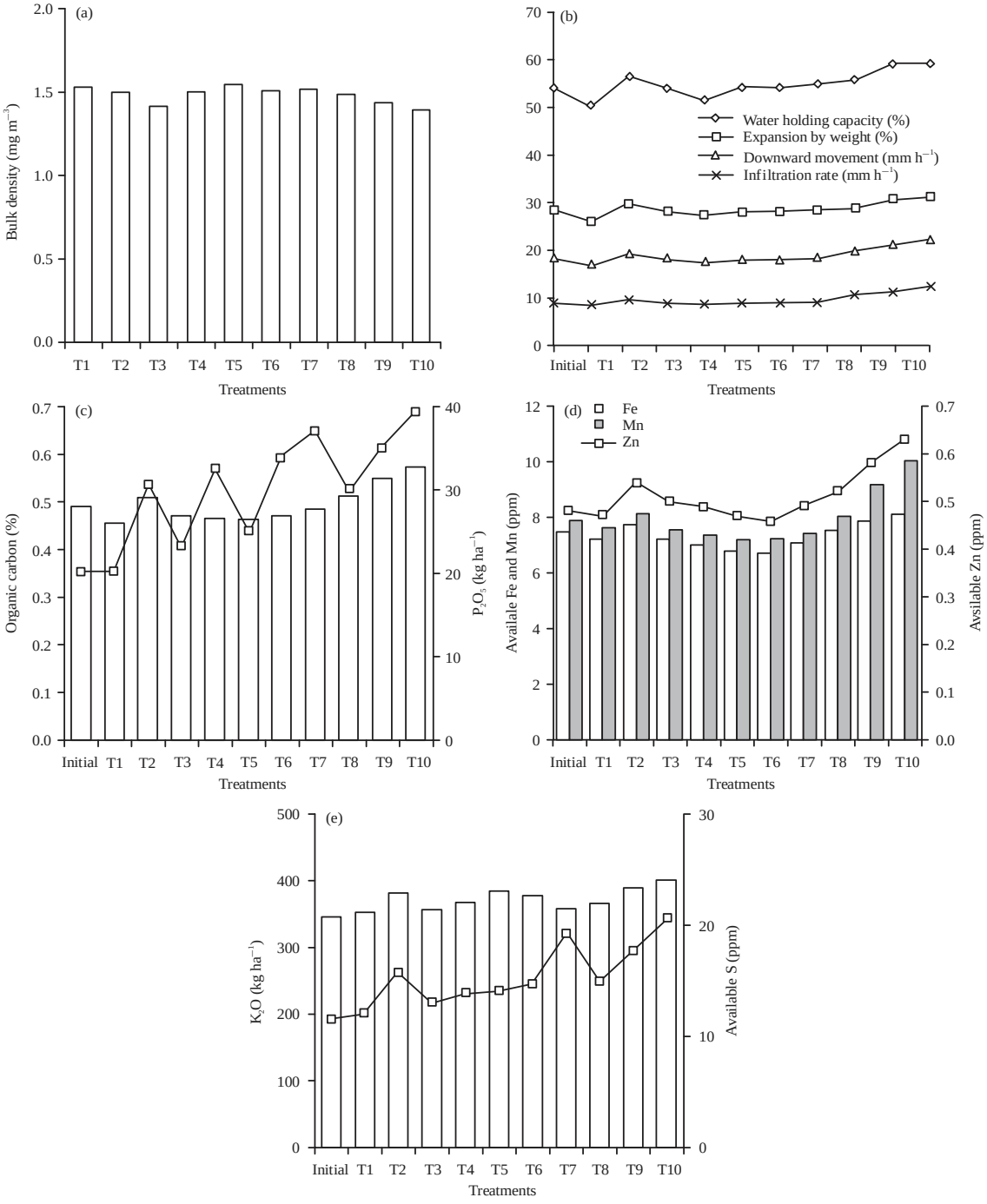

Fig. 1(a-e): (a) Bulk density, (b) Water holding capacity, downward movement of water and infiltration rate, (c) Organic carbon and potash, (d) Available micronutrients and (e) Potash and sulphur

of 80 kg N ha^{-1} +10 t compost ha^{-1} +500 kg castor cake ha^{-1} +bio-fertilizer (T_9) gave the highest total income (Rs. 125300 ha^{-1}) and net return (Rs. 98289 ha^{-1}).

Table 4: Post harvest soil fertility status (2013)

Treatments	pH	EC (dS m^{-1})	OC (%)	P_2O_5 (kg ha^{-1})	K_2O (kg ha^{-1})	Available S (ppm)	DTPA extractable micronutrients (ppm)		
							Fe	Zn	Mn
Initial	8.00	0.19	0.493	20.30	346	11.5	7.52	0.48	7.88
T1	8.14	0.26	0.457	20.20	354	12.1	7.24	0.47	7.61
T2	8.15	0.25	0.510	30.80	383	15.7	7.76	0.54	8.14
T3	8.14	0.26	0.474	23.20	358	13.1	7.24	0.50	7.58
T4	8.15	0.23	0.466	32.80	368	13.9	7.04	0.49	7.37
T5	8.17	0.28	0.462	25.10	385	14.1	6.80	0.47	7.19
T6	8.15	0.27	0.470	34.10	378	14.7	6.72	0.46	7.26
T7	8.12	0.27	0.490	37.20	359	19.3	7.10	0.49	7.43
T8	8.18	0.23	0.514	30.10	366	14.9	7.53	0.52	8.04
T9	8.17	0.30	0.551	35.10	391	17.7	7.88	0.58	9.18
T10	8.18	0.31	0.575	39.50	402	20.6	8.12	0.63	10.06
M±SE	0.06	0.01	0.018	2.07	10	1.1	0.21	0.02	0.25
CD 5%	NS	0.04	0.054	6.16	29	3.2	0.63	0.07	0.74
CV (%)	1.34	9.54	6.350	11.66	5	12.1	5.01	7.69	5.43

EC: Electrical conductivity, OC: Organic carbon, DTPA: Diethylene triamine penta-acetic acid, M±S.E: Standard error of the mean, CV: Coefficient of variance

Table 5: Effect of integrated nutrient management on economics

Treatments	Cotton seed yield (kg ha^{-1})	Gross income (Rs ha^{-1})	Cost of cultivation (Rs ha^{-1})	Net return (Rs ha^{-1})	B:C ratio
T1	1167	58350	16150	42200	2.61
T2	1789	89450	22400	67050	2.99
T3	2053	102650	17411	85239	4.89
T4	2133	106650	19977	86673	4.33
T5	2123	106150	18592	87558	4.70
T6	2124	106200	21158	85042	4.02
T7	2186	109300	20075	89225	4.44
T8	2119	105950	20911	85039	4.07
T9	2506	125300	27011	98289	3.64
T10	1926	96300	26950	69350	2.57

CONCLUSION

From the above study it is concluded that in North Saurashtra Agro climatic zone (AES-VI) under rainfed condition Bt cotton should be fertilized with 80 kg N +10 t compost+500 kg castor cake+bio-fertilizer or 80 kg N+40 kg P_2O_5+250 kg gypsum ha^{-1} for obtaining higher yield as well as maximum net return and improving soil fertility.

REFERENCES

Anonymous, 2010. Annual report. All India Coordinated Cotton Improvement Project.

Das, A., M. Prasad, Y.S. Shivay and K.M. Subha, 2004. Productivity and sustainability of cotton (*Gossypium hirsutum* L.) wheat (*Triticum aestivum* L.) cropping system as influenced by prilled urea, farmyard manure and *Azotobacter*. J. Agron. Crop Sci., 190: 298-304.

Deshmukh, M.S., V.D. Patil, A.S. Jadhav, G.D. Gadade and A.L. Dhamak, 2013. Assessment of soil quality parameters and yield of rainfed Bt. Cotton as influenced by application of herbicides in Vertisols. Int. J. Agric. Sci., 3: 553-557.

Gadhiya, S.S., B.B. Patel, N.J. Jadav, R.P. Pavaya, M.V. Patel and V.R. Patel, 2009. Effect of different levels of nitrogen, phosphorus and potassium on growth, yield and quality of Bt cotton. Asian J. Soil Sci., 4: 37-42.

Hosamani, V., A.S. Halepyati, M. Shashikumar, U.N. Santhosh, M. Nataraja and T.G. Manu, 2013. Quality, uptake of nutrients and economics of irrigated Bt cotton (*Gossypium hirsutum* L.) as influenced by macro nutrients and liquid fertilizers. Global J. Biol. Agric. Health Sci., 2: 29-32.

Islam, M.K., Khalequzzaman, M.K. Hassan and M. Kaikobad, 2014. Annual research report. Cotton Development Board, Ministry of Agriculture, Bangladesh, pp: 131-142.

Laekemariam, F. and G. Gidago, 2012. Response of maize (*Zea mays* L.) to integrated fertilizer application in Wolaita, South Ethiopia. Adv. Life Sci. Technol., 5: 21-30.

Mayee, C.D., D. Monga, S.S. Dhillon, P.L. Nehra and P. Pundhir, 2008. Cotton-wheat production system in South Asia: A success story. Asia-Pacific Association of Agricultural Research Institutions, Bangkok, pp: 1-48.

Rathod, D.D., M.C. Meena and K.P. Patel, 2012. Effect of different Zn-enriched organics on yields and micronutrient uptake under Wheat-Maize (Fodder) cropping sequence in semi-arid region of Gujarat. Ind. J. Dryland Agric. Res. Dev., 27: 37-42.

Salem, H.M. and N.K.B. El-Gizawy, 2012. Importance of micronutrients and its application methods for improving maize (*Zea mays* L.) yield grown in clayey soil. Am. Eurasian J. Agric. Environ. Sci., 12: 954-959.

Sridevi, S. and K. Ramakrishnan, 2010. The effect of NPK fertilizer and AM fungi on the growth and yield of cotton (*Gossypium hirsutum* L.) Var. LRA 5166. Recent Res. Sci. Techno., 2: 39-41.

Usman, K., N. Khan, M.U. Khan, A. Rehman and S. Ghulam, 2013. Impact of tillage and herbicides on weed density, yield and quality of cotton in wheat based cropping system. J. Integr. Agr., 12: 1568-1579.

Yang, F., M. Du, X. Tian, A.E. Eneji, L. Duan and Z. Li, 2014. Plant growth regulation enhanced potassium uptake and use efficiency in cotton. Field Crop. Res., 163: 109-118.