Available online at www.ijpab.com

DOI: http://dx.doi.org/10.18782/2320-7051.6131

ISSN: 2320 – 7051

Int. J. Pure App. Biosci. **5 (6):** 1210-1217 (2017)

Research Article

International Journal of Pure & Applied Bioscience

OPEN ACCESS

Effect of High Density Planting, Nutrient Management and Moisture Conservation on Economics and Nutrient Uptake of *Hirsutum* Cotton under Rainfed Condition

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Received: 5.11.2017 | Revised: 9.12.2017 | Accepted: 14.12.2017

ABSTRACT

A Field experiment was conducted during kharif 2012 and 2013 on the Agronomy farm of Department of Agronomy, Dr. PDKV, Akola of clay texture soil. The results revealed that plant density of 1,66,666 plants ha^{-1} at spacing (60 x 10 cm^2) recorded higher gross monetary returns (Rs. 99,157 ha^{-1}), but plant density of 1,11,111 plants ha^{-1} at spacing (60 x 15 cm^2) recorded highest net monetary returns and benefit cost ratio (Rs. 58,814 ha^{-1} and 2.61) in pooled analysis. Highest uptake of NPK and micronutrients (Zn, Fe, Mn and Cu) were recorded with plant density of 1,66,666 plants ha^{-1}. Whereas, increment in nutrient management treatment 150% RDF + Foliar spraying of 2.0% DAP at flowering (60 DAS), 1.0% $MgSO_4$ + 0.5% $ZnSO_4$ at boll development stage (80 DAS), was significantly increased in seed cotton yield and uptake of nutrient NPK and micronutrients towards 100% RDF (F_1) and 100% RDF + micronutrient (F_3) except 150% RDF (F_2). Moisture conservation technique of opening of furrows 30 days after emergence (DAE) has higher profitability in terms of gross monetary return, net monetary return, benefit cost ratio and uptake of NPK and micronutrients by cotton plant.

Key words: *High Plant Density, Nutrient Management, Moisture Conservation, Economics, Uptake of NPK.*

INTRODUCTION

Cotton (*Gossypium hirsutum)*, the 'White Gold' is one of the most important commercial and industrial crop and plays a key role in economical and social affairs of the world. It is considered as "King of fibres" and is important cash of this country. There by cotton crop assumes a place of special significance in Indian economy. Agronomic practices like maintenance of ideal plant density, use of optimum dose of fertilizer and moisture conservation play a key role in enhancing the productivity. Plant may show better growth and development and give highest yield per plant but may not give maximum yield per unite area because of inadequate plant population. Thus, for increasing economic yield, the optimum spacing is essential. Along with this nutrient supply is the most important limiting factor in cotton production.

Cite this article: Khargkharate, V.K., Ghanbahadur, M., Hiwale, S., Chirde, P. and Shaikh, S.A., Effect of High Density Planting, Nutrient Management and Moisture Conservation on Economics and Nutrient Uptake of *Hirsutum* Cotton under Rainfed Condition, *Int. J. Pure App. Biosci.* **5(6):** 1210-1217 (2017). doi: http://dx.doi.org/10.18782/2320-7051.6131

The nutrient management in cotton is a complex phenomenon due to its long duration and in determining growth habit, where simultaneous production of vegetative and reproductive structure during the active growth phase takes place. The manipulation of plant density and crop spacing is a time tested agronomic technique to improve yield and profitability[29]. As plant density increases the cumulative demand for sunlight, water and nutrient uptake increases and leading to more rapid canopy closure and decreased soil water evaporation, is becoming popular to address water scarcity challenges. The adoption of HDPS, along with good nutrient management and better genotypes, is a viable approach to break the current trend of stagnating yields under primarily rainfed *hirsutum* cotton growing areas. So trend towards high density planting is moving fast. Essential micronutrient like Zinc and Magnesium play an important role in physiology of cotton crop being a part of enzyme system or catalyst in enzymatic reactions. They are required for plant activities such as aspiration, meristematic development, chlorophyll formation, photosynthesis, energy system, protein and oil synthesis, gossypol, tannin and phenolic compounds development. Foliar application of micronutrients plays an important role in changing physiological and biochemical processes in cotton[19]. In *situ* moisture conservation as the soil profile is reservoir for moisture storage and this facility needs to be exploited to the maximum. Sometimes at critical growth stage of crop like flowering and boll formation. As stand density increase the total communal demand for sunlight, water and nutrient uptake increase.

MATERIALS AND METHODS

The field experiment was conducted during *kharif* season of 2012 and 2013 on Agronomy farm of Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola in split plot design with three replication. The treatment combination comprised of three crop densities viz. The S_1- 60 x 10 cm^2 (1,66,666 plants ha^{-1}), S_2- 60 x 15 cm^2 (1,11,111 plants ha^{-1}) and S_3- 60 x 30 cm^2 (55,555 plants ha^{-1}) in the main plots and four levels of fertilizer 100% RDF (F_1) *i.e.* 50:25:25 kg $N:P_2O_5:K_2O$ ha^{-1} , 150% RDF (F_2) *i.e.* 75:37.5:37.5 kg $N:P_2O_5:K_2O$ ha^{-1}, F_3- 100% RDF + Foliar spraying of 2.0% DAP at flowering, 1.0% $MgSO_4$ and 0.5% $ZnSO_4$ at boll development stage and F_4- 150% RDF + Foliar spraying of 2.0% DAP at flowering (60 DAS), 1.0% $MgSO_4$ and 0.5% $ZnSO_4$ at boll development stage (80 DAS) and two moisture conservation practices M_1- Sowing on flat bed and M_2- Opening of furrow 30 DAE were combinely allotted in subplots. The soil of the experimental field was clayey in texture, slightly alkaline having pH- 8.1, EC- 0.30 (dsm^{-1}), organic carbon 0.61% and available N,P,K,Zn and Fe status of the soil was 208 kg ha^{-1}, 17.32 kg ha^{-1}, 336 kg ha^{-1}, 0.610 mg kg^{-1} and 5.57 mg kg^{-1} respectively. Sowing of experiment was done on 01.07.2012 and 12.06.2013 respectively. The representative sample was analyzed NPK by using standard procedure[8]. DTPA extractable micronutrients (Zn, Fe, Mn and Cu) were determined as per the method described by Lindsay and Norvell[11]. Oven dried plant sampled were ground to required fineness, digested for Zn, Fe, Mn, Cu and B determinations. Zinc, iron, manganese and copper content in plant digest were determined on atomic absorption spectrophotometer as outlined by Dhyan Singh *et. al*[5]. The nutrient uptake was worked out by multiplying the nutrient concentration in partitioning of dry matter yield dividing by 100. The total precipitation was recorded during growth period 592.8 mm and 946.4 mm, during 2012 and 2013 respectively.

RESULT AND DISCUSSION

Effect of plant density

Increase in seed cotton yield in closer spacing was due to significantly higher plant population per unit area. Wider spacing recorded more number of picked bolls and yield $plant^{-1}$ but higher plant population, which compensated the yield $plant^{-1}$ even though there were lesser number of picked bolls and yield $plant^{-1}$. Similar result were also reported by Reddy and Kumar[24]. The increased in seed

cotton yield under highest plant density of 1,66,666 plants ha^{-1} (60 x 10 cm^2) over lower plant density of 1,11,111 plants ha^{-1} (60 x 15 cm^2) and 55,555 plants ha^{-1} (60 x 30 cm^2) to the tune of 4.62 and 38.79 per cent and 3.50 and 39.95 per cent during 2012 and 2013, respectively. Similar results were also reported by Bhalerao and Gaikwad[3].Plant density of 1,66,666 plants ha^{-1} (60 x 10 cm^2) recorded significantly higher gross monetary returns of Rs. 93,307, Rs. 1,05,006 and Rs. 99,157 ha^{-1} as compared to 1,11,111 plants ha^{-1} (60 x 15 cm^2) and 55,555 plants ha^{-1} (60 x 30 cm^2) during 2012, 2013 and in pooled results, respectively. The highest gross monetary returns were recorded in the plant density of 1,66,666 plants ha^{-1} (60 x 10 cm^2) to the tune of 4.25 and 39.86 per cent more than 1,11,111 plants ha^{-1} (60 x 15 cm^2) and 55,555 plants ha^{-1} (60 x 30 cm^2) respectively in pooled analysis. These results are agreement with Raut *et. al.* (2005[a]), Chavan *et. al.*[4] and Paslawar *et. al*[16] .

The higher plant density per unit area in 1,66,666 plants ha^{-1} (60 x 10 cm^2) recorded significantly higher net monetary returns of Rs. 55,414, Rs. 64,824 and Rs. 60,119 ha^{-1} as compared to lower plant density in 55,555 plants ha^{-1} (60 x 30 cm^2) but found at par with 1,11,111 plants ha^{-1} during 2012, 2013 and in pooled results, respectively. Plant density of 1,11,111 plants ha^{-1} (60 x 15 cm^2), which was 53.65 and 50.31 per cent more as compared to plant population 55,555 plants ha^{-1} (60 x 30 cm^2). Increase of 100 per cent plant population than recommended, increased seed cotton yield, net monetary returns and benefit cost ratio. Due to higher plant density 1,66,666 plants ha^{-1} increased the cost of cultivation than 1,11,111 plants ha^{-1}, because of higher seed rate ha^{-1}. Similar findings were also reported by Raut *et. al.*[22] and Srinivasulu *et. al*[27]. Similarly increase in benefit cost ratio under higher plant density were reported by Bhalerao and Gaikwad[3] , Reddy and Kumar[24], Chavan *et. al.*[4], Mohaptra and Nanda[14] and Pawar *et. al*[17].

Effect of nutrient management

Among the nutrient management, highest seed cotton yield were recorded with application of 150% RDF+ Foliar spraying of 2.0% DAP at flowering (60 DAS) and 1.0% $MgSO_4$ + 0.5% $ZnSO_4$ (F_4) at boll development stage (80 DAS) was significantly superior over 150% RDF (F_2), 100% RDF+ Foliar spraying of 2.0% DAP at flowering and 1.0% $MgSO_4$ + 0.5% $ZnSO_4$ (F_3) at boll development stage and 100% RDF i.e. 50:25:25 kg $N:P_2O_5:K_2O$ ha^{-1} (F_1) during both the years of experimentation and in pooled data. On an average application of 150% RDF+ Foliar spraying of 2.0% DAP, 1.0% $MgSO_4$ + 0.5% $ZnSO_4$ (F_4) produced 7.39 percent more seed cotton yield than 150% RDF (F_2). However, 100% RDF + Foliar spraying of 2.0% DAP, 1.0% $MgSO_4$ + 0.5% $ZnSO_4$ (F_3) produced 12.28 per cent more seed cotton yield than 100% RDF (F_1). Similarly nutrient management treatment i.e., 150% RDF+ Foliar spraying of 2.0% DAP, 1.0% $MgSO_4$ + 0.5% $ZnSO_4$ (F_4) produced 32.62 per cent seed cotton yield than 100% RDF(F_1). Similar findings also reported by Pawar *et. al.*[17], Reddy and Gopinath[23].These results are in conformity with the findings of Modhavadia *et. al*[13]. Different levels of nutrient management significantly influenced gross monetary returns. Nutrient management treatment of 150% RDF + Foliar spraying of 2.0% DAP, 1.0% $MgSO_4$ + 0.5% $ZnSO_4$ (F_4) recorded 35.01 percent more gross monetary return than 100% RDF (F_1) in pooled study. Increased in level of 150% RDF + Foliar spraying of 2.0% DAP, 1.0% $MgSO_4$ + 0.5% $ZnSO_4$ (F_4) increase the seed cotton and stalk yield and finally increased gross monetary returns. Treatment of nutrient management 150% RDF+ Foliar spraying of 2.0% DAP, 1.0% $MgSO_4$ + 0.5% $ZnSO_4$ (F_4) increased 48.71, 9.13 and 28.05 per cent more net monetary returns than 100% RDF (F_1), 150% RDF (F_2) and 100% RDF+ Foliar spraying of 2.0% DAP at flowering (60 DAS) and 1.0% $MgSO_4$ + 0.5% $ZnSO_4$ at boll development stage (80 DAS) (F_3) respectively. These findings are accordance with the findings of Srinivasulu *et. al*[27], Reddy and Gopinath[23], Bhalerao and Gaikwad[3] and Pawar *et. al*[17]. Nutrient management 150% RDF + Foliar

spraying of 2.0% DAP, 1.0% $MgSO_4$ + 0.5% $ZnSO_4$ (F_4) recorded maximum benefit:cost ratio 2.74 than 100% RDF i.e., 50:25:25 kg $N:P_2O_5:K_2O$ ha^{-1} (F_1). These results are in agreement with the findings of Modhavadia *et. al*[12].

Effect of moisture conservation practices

The seed cotton yield was significantly influenced due to moisture conservation practices under study, wherein opening of furrow of 30 DAE (M_2) produced the highest seed cotton yield of 2114, 2318 and 2216 Kg ha^{-1} during 2012, 2013 and in pooled results, respectively over sowing on flat bed (M_1). Results of present investigation are similar with the findings of Singh *et. al.*[26] and Asewar *et. al*[2]. The opening of furrow 30 DAE (M_2) recorded higher gross monetary returns Rs. 86,490, Rs.95,907 and Rs.91,199 ha^{-1} during 2012, 2013 and in pooled data. In pooled result opening of furrow 30 DAE (M_2) recorded 6.56 per cent more gross monetary returns than flat bed sowing (M_1). These results are confirmed by Gaidhane *et. al*[6]. and Kolekar[10]. The opening of furrow 30 DAE recorded the highest net monetary returns of Rs. 50,930, Rs. 58,592 and Rs. 54,761 ha^{-1} during 2012, 2013 and in pooled results, respectively and it was significantly superior over net returns in flat bed sowing. In pooled results, where in opening of furrow 30 DAE (M_2) recorded significantly higher benefit cost ratio over flat bed sowing (M_1) during 2012 and 2013. These results are confirmed by Tayade[28] and Alloli, *et. Al*[1].

Table 1: Effect of Plant density, moisture conservation practices and nutrient management on Seed cotton yield, Gross monetary returns, Net monetary returns and B:C ratio during 2012 and 2013

Treatments	Seed cotton yield (Kg ha^{-1})			Gross monetary returns (Rs. ha^{-1})			Net monetary returns (Rs. ha^{-1})			B:C ratio	
	2012	2013	Pooled	2012	2013	Pooled	2012	2013	Pooled	2012	2013
Spacing											
S_1 - 60 x 10 cm^2 (1,66,666 plants ha^{-1})	2275	2533	2404	93307	105006	99157	55414	64824	60119	2.45	2.60
S_2 - 60 x 15 cm^2 (1,11,111 plants ha^{-1})	2174	2447	2311	89050	101180	95115	53649	63979	58814	2.51	2.71
S_3 - 60 x 30 cm^2 (55,555 plants ha^{-1})	1639	1810	1725	66999	74800	70900	35698	42556	39127	2.13	2.30
S. E. (m) ±	32.17	29.78	29.13	1274	915	883	1274	915	870	-	-
C. D. at 5%	101.37	93.7	93.31	4014	2882	3206	4014	2882	3159	-	-
Moisture conservation practices											
M_1 - Sowing on flat bed	1945	2208	2077	79748	91417	85582	45578	55647	50613	2.32	2.53
M_2 – Opening of furrow 30 DAE	2114	2318	2216	86490	95908	91199	50930	58592	54761	2.41	2.55
S. E. (m) ±	26.27	24.31	27.25	1040	747	721	1040	747	710	-	-
C. D. at 5%	82.77	76.51	82.62	3278	2353	2618	3278	2353	2579	-	-
Nutrient management											
F_1 - 100% RDF (50:25:25 NPK kg ha^{-1})	1702	1919	1811	69874	79603	74738	37983	46130	42057	2.17	2.36
F_2 - 150% RDF (75:37.5:37.5 NPK kg ha^{-1})	2157	2416	2287	88394	99903	94148	52500	62115	57308	2.45	2.63
F_3 - 100% RDF + 2.0% DAP, 1.0% $MgSO_4$ + 0.5% $ZnSO_4$	1920	2146	2033	78637	88884	83760	44504	53176	48840	2.30	2.48
F_4 - 150% RDF + 2.0% DAP, 1.0% $MgSO_4$ + 0.5% $ZnSO_4$	2338	2573	2456	95555	106257	100906	58028	67057	62543	2.53	2.70
S. E. (m) ±	21.07	19.02	16.45	835	766	588	835	766	617	-	-
C. D. at 5%	58.3	52.63	48.23	2310	2199	1719	2310	2199	1802	-	-
Interaction effect											
S x M											
S. E. (m) ±	45.50	42.12	29.88	1801.72	1293.45	1257.2	1801.72	1293.45	1232.4	-	-
C. D. at 5%	NS	NS	108.47	NS	NS	NS	NS	NS	NS	-	-
S x F											
S. E. (m) ±	45.49	32.94	25.04	1445.7	1326.73	1011.8	1445.7	1326.73	1007.6	-	-
C. D. at 5%	137.08	NS	NS	NS	NS	NS	NS	NS	2939.47	-	-
M x F											
S. E. (m) ±	29.79	57.25	20.30	1181.4	1083.27	826.13	1181.4	1083.27	823.63	-	-
C. D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	-	-
S x M x F											
S. E. (m) ±	51.61	99.17	35.16	2044.25	1876.29	1430.9	2046.25	1876.29	1427.63	-	-
C. D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	-	-
GM	2030	2263	2146	83115	93662	88390	48254	57119	52687	2.36	2.54

Interaction effect

Table 2: Seed cotton yield (kg ha $^{-1}$) as influenced by S x F interaction at harvest during 2012

S x F	At harvest (2012)			
	F_1	F_2	F_3	F_4
S_1	1944	2376	2144	2637
S_2	1855	2350	1988	2505
S_3	1308	1742	1629	1877
S. E. (m) ±	45.49			
C. D. at 5%	137.08			

Plant density and nutrient management (S x F) interaction was found to be significant. The data presented in (Table 2) indicated that higher plant population 1,66,666 plants ha^{-1} recorded highest seed cotton yield 2637 kg ha^{-1} with increasing level of nutrient management 150% RDF i.e.,75:37.5:37.5 kg N:P_2O_5:K_2O ha^{-1} + Foliar spraying of 2.0% DAP, 1.0% $MgSO_4$ + 0.5% $ZnSO_4$.

Uptake of NPK and Micronutrient

The data (Table 3) showed that maximum uptake of N was noticed with plant density 1,66,666 plants ha^{-1} followed by 1,11,111 plants ha^{-1} while lowest uptake of nitrogen noticed under 55,555 plants ha^{-1}. Similar trend was recorded for uptake of P and K by *hirsutum* cotton. It was interesting to note that higher plant density per unit area removed greater amount of NPK from soil Ravankar and Deshmukh[20,21] and Sawan *et. al*[25]. Significantly lowest uptake of N was seen with 100% RDF i.e. 50:25:25 N,P_2O_5 and K_2O kg ha^{-1} and similarly P and k were significantly less in 100% RDF. Application of Phosphorus significantly affected the total uptake of N, P and K in cotton. Where in the highest value was obtained with 37.5 Kg P_2O_5 kg ha^{-1} over 25 kg P_2O_5 ha^{-1}. The uptake of potassium by *hirsutum* cotton was maximum with plant density of 1,66,666 plants ha^{-1} (52.92 and 59.99 kg ha^{-1}) followed by 1,11,111 plants ha^{-1} (48.55 and 54.79 kg ha^{-1}) and 55,555 plants ha^{-1} (41.36 and 46.80 kg ha^{-1}) during 2012 and 2013 respectively. In respect of micronutrients (Zn, Fe, Mg, and Cu) uptake, The uptake of Zn was noticed significantly superior with plant density 1,66,666 plants ha^{-1} (117.07 and 137.37 mg kg^{-1}) followed by 1,11,111 plants ha^{-1} (106.55 and 127.89 mg kg^{-1}) and 55,555 plants ha^{-1} (90.17 and 104.88 mg kg^{-1}) during 2012 and 2013 respectively, Similar trend was recorded for uptake of Mn and Cu by *hirsutum* cotton during both the years of experimentation. Highest N,P and K uptake was observed with application of 150% RDF + 2% DAP at flowering (60 DAS) and 1% $MgSO_4$ + 0.5 % $ZnSO_4$ at boll formation (80 DAS) which was significantly superior to 100% RDF (F_1), 100% RDF + 2% DAP, 1% $MgSO_4$ +0.5 % $ZnSO_4$ and 150% RDF (F_2) i.e. 75: 37.5: 37.5 N,P_2O_5 and K_2O kg ha^{-1}. Every higher application of nutrient management noted significantly increase in P and K uptake over its lower levels. Balanced and Optimum application of NPK and micronutrient increased the concentration and uptake of NPK and micronutrient (Zn, Fe, Mn, Cu). Similar results were reported earlier by Ravankar *et. al*[20,21], Katkar *et. al.*[9] and Waikar *et. al*[30]. The micronutrient uptake significantly increased with foliar spraying of different nutrient combination and this could be due to higher dry matter production and highest seed cotton yield[7].Moisture conservation techniques of opening of furrows 30 DAE (M_2) recorded significantly higher nutrient uptake of NPK and micronutrients over flat bed sowing (M_1). It may be due to availability of moisture, which help to reflect the nutrient in soil, uptake in plant and increased dry matter accumulation. As regards to in situ moisture conservation techniques opening of furrows 30 DAE recorded significantly higher uptake of N (46.56 and 54.35 kg ha^{-1}), P (17.65 and 18.86 kg ha^{-1}) and K (49.57 and 55.63 kg ha^{-1}) as compared to flat bed sowing (42.67 and 50.41 kg ha^{-1}), (15.94 and 17.21 kg ha^{-1}) and (45.65 and 52.10 kg ha^{-1}) N,P and K Kg ha^{-1} during 2012 and 2013 respectively. Similar trend was recorded for uptake of micronutrients (Zn, Fe, Mn and Cu) by *hirsutum* cotton during both the year of study.

Table 3: Effect of plant density, moisture conservation practices and nutrient management on uptake of macro and micro nutrients by *hirsutum*cottonduring 2012 and 2013

Treatments	Uptake of NPK (kg ha^{-1})						Uptake of micronutrients (mg ka^{-1})							
	N		P		K		Zn		Fe		Mn		Cu	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
Spacing														
S_1 - 60 x 10 cm^2 (1,66,666 plants ha^{-1})	48.61	58.64	18.40	19.79	52.92	59.99	117.03	137.37	676.97	753.55	104.69	132.07	76.67	94.12
S_2 - 60 x 15 cm^2 (1,11,111 plants ha^{-1})	46.01	53.14	17.33	18.39	48.55	54.79	106.55	122.89	604.63	656.62	96.20	118.76	70.99	84.28
S_3 - 60 x 30 cm^2 (55,555 plants ha^{-1})	39.23	45.36	14.67	15.64	41.36	46.8	90.17	104.68	464.29	517.89	83.84	104.04	58.15	70.81
S. E. (m) ±	0.6	0.48	0.188	0.141	0.546	0.579	1.43	1.68	6.93	6.47	1.22	0.57	0.97	0.54
C. D. at 5%	1.89	1.5	0.593	0.444	1.721	1.634	4.51	5.30	21.82	20.39	3.85	1.78	3.04	1.71
Moisture conservation practices														
M_1 - Sowing on flat bed	42.67	50.41	15.94	17.21	45.65	52.1	100.69	117.52	562.05	621.91	90.87	113.85	65.98	80.13
M_2 – Opening of furrow 30 DAE	46.56	54.35	17.65	18.86	49.57	55.63	108.48	125.77	601.88	663.47	98.95	122.73	71.22	86.01
S. E. (m) ±	0.49	0.39	0.154	0.12	0.446	0.424	1.17	1.37	5.66	5.28	1.00	0.46	0.79	0.44
C. D. at 5%	1.54	1.22	0.484	0.36	1.405	1.334	3.68	4.32	17.82	16.65	3.14	1.45	2.48	1.40
Nutrient management														
F_1 - 100% RDF (50:25:25 NPK kg ha^{-1})	37.75	45.13	14.21	15.51	41.07	47.25	91.86	108.55	511.84	573.24	82.10	103.90	59.89	73.51
F_2 - 150% RDF (75:37.5:37.5 NPK kg ha^{-1})	48.13	55.72	18.02	19.16	50.56	56.78	110.21	127.28	608.61	666.74	100.49	124.28	72.21	86.87
F_3 - 100% RDF + 2.0% DAP, 1.0% $MgSO_4$ + 0.5% $ZnSO_4$	42.13	49.83	16.01	17.22	45.41	51.61	100.67	116.92	566.92	624.92	90.93	113.31	66.28	80.06
F_4 - 150% RDF + 2.0% DAP, 1.0% $MgSO_4$ + 0.5% $ZnSO_4$	50.35	58.85	18.95	20.27	53.4	59.85	115.59	133.83	640.48	705.85	106.13	131.68	76.02	91.86
S. E. (m) ±	0.32	0.44	0.104	0.11	0.337	0.453	0.65	0.76	5.85	4.13	0.58	0.69	0.44	0.47
C. D. at 5%	0.92	1.27	0.299	0.33	0.966	1.301	1.87	2.18	16.78	11.87	1.68	1.97	1.27	1.36
Interaction effect														
S x M														
S. E. (m) ±	0.85	0.67	0.266	0.2	0.772	0.734	2.03	2.38	9.80	9.15	1.73	0.80	1.37	0.77
C. D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
S x F														
S. E. (m) ±	0.56	0.77	0.237	0.221	1.038	1.185	1.13	1.32	10.13	7.16	1.01	1.19	1.08	0.82
C. D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
M x F														
S. E. (m) ±	0.45	0.63	0.147	0.16	0.476	0.641	0.92	1.07	8.27	5.85	0.83	0.97	0.62	0.67
C. D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
S x M x F														
S. E. (m) ±	0.79	1.09	0.285	0.28	0.825	1.11	1.60	1.86	14.32	10.13	1.43	1.68	1.08	1.16
C. D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
GM	44.61	54.38	16.8	18.24	47.61	53.78	104.59	121.65	581.96	642.69	94.91	118.29	68.60	83.07

CONCLUSION

On the basis of two years data, it can be concluded that plant density of 1,11,111 plants ha^{-1} (60 x 15 cm^2) with opening of furrow 30 DAE and 150% RDF + Foliar spraying of 2.0% DAP at flowering (60 DAS), 1.0% $MgSO_4$ + 0.5% $ZnSO_4$ at boll development stage (80 DAS) for obtaining higher seed

cotton yield and found productive, remunerative and profitable of *hirsutum* cotton (AKH- 081) under rainfed condition of Vidarbha region of Maharashtra.

REFERENCES

1. Alloli, T.B., Hullihali, U.K. and Athani, S.J. Influence of in-situ moisture conservation practices on the performance of dryland chilli. *Karnataka J. Agric. Sci*. **21(2):** 253-255 (2008).
2. Asewar, B.V., Jadhav, A.S. and Khan, Y.A. Effect of in-situ water management and intercropping systems on yield of rainfed cotton. *J. Cotton Res. Dev*. **22(2):** 173-175 (2008).
3. Bhalerao, P.D. and Gaikwad, G.S. Productivity and profitability of *Bt* cotton (*Gossypium hirsutum*) under various plant geometry and fertilizer levels. *Indian J. Agronomy*. **55(1):** 60-63 (2010).
4. Chavan, N.H., Nagrare, I.M., Patil, D.B., Patil, N.A. and Sathe, H.D. Effect of spacing and fertilizers levels on yield attributes and economics of *Bt* cotton. *J. of Soils and Crops.* **21(1):** 148-151 (2011).
5. Dhyan Singh., Chhonkar, P.K. and Dwivedi, B.S. Manual on soil, plant and water analysis. Westville Publishing House, New Delhi. 200 (2005).
6. Gaidhane, S.N., Mankar, P.S., Khawale, V.S., Yenpreddiwar, M.D. and Idapaganti, Effect of land configuration and mulches on growth and yield of arborium cotton. *J. Soils and crops.* **17(2):** 403-406 (2007).
7. Ishaq, H.M. Effects of foliar micronutrient fertilizers on the yield of irrigated cotton on the vertisols of the Sudan Gezira. *Expl Agric*. **28(3):** 265-271 (1992).
8. Jackson, M.L. Soil chemical analysis, Prentice Hall of India Pvt.Ltd., New Delhi (1973).
9. Katkar, R.N., Turkhede, A.B., Wankhade, S.T. and Solanke, V.M. Studies on the agronomic requirement of promising cotton hybrids. *Crop Res*. **19(3):** 525-526 (2000).
10. Kolekar, B.P. Cotton productivity and quality as influenced by land configuration and nutrient management. M.Sc. Thesis (Unpub.) Dr. PDKV, Akola (2009).
11. Lindsay, W.L. and Norvell, W.A. Development of DTPA soil test for zinc, manganese and copper. *Soil Sci. Soc. of American J*. **42:** 412-428 (1978).
12. Modhavadia, J.M., Nariya, J.N., Vadaria, K.N. and Thanki, R.B. Effect of fertilizer management on yield and economics of hybrid *Bt* cotton. *Asain J. of soil sci.* **6(1):** 97-100 (2011).
13. Modhavadia, M.M., Solanki, R.M., Nariya, J.N., Vadaria, K.N. and Rathod, A.D. Effect of different levels of nitrogen, phosphorus and potassium on growth, yield and quality of Bt cotton hybrid under irrigated conditions. *J. Cotton Res. Dev.* **26(1):** 47-51 (2012).
14. Mohapatra, S.C. and Nanda, S.S. Response of various levels of nutrient and spacing in non-*Bt*. Hybrid cotton (*Gossypium hirsutum*) under rainfed situation. *Res. J. Agric. Sci* **2(1):** 162-163 (2011).
15. Namdev, K.N., Sharma, J.K. and Mandoli, K.C. Effect of foliar feeding of micro-nutrients on rainfed hybrid cotton (JK Hy. 1). *Crop Research*. **5:** 451-455 (1992).
16. Paslawar, A.N., Deotalu, A.S. and Nemade, P.W. High density planting of cotton variety AKH – 081 under rainfed condition of Vidharbha plant archives. **15(02):** 1075-1077 (2015).
17. Pawar, S.U., Gite, A.N., Hsan Bin Awaz and Kharwade, M.L. Effect of spacing and fertilizer levels on yield attributes, seed cotton yield and economics of *Bt*. Cotton. *J. Agric. Res. Tech.* **36(1):** 168-170 (2011).
18. Pinjari, S.S., Pawar, P.P. and Mhasker, M.V. Response of irrigated cotton (JLH-168) to different levels and sources of fertilizer. *J. Crop. Prot. Prod.* **2(2):** 120-121 (2006).
19. Radhika, K., Hemalatha, S., Praveen Katharina, S., Maragathan, S. and Kanimozhi, A. Foliar application of micronutrients in cotton-a review. *Research and review*, **2(3):** 23-29 (2013).

20. Ravankar, H.N., Thakare, V.S. and Deshmukh V.A. Response of newly evolved cotton hybrids to various agronomic practices. *PKV Res. J.* **18:**14-17 (1994).
21. Ravankar, H.N. and Deshmukh, V.A. Study on nutrient uptake pattern in H-4 cotton under different agronomic management. *PKV Res. J*. **18(1):** 60-62 (1994).
22. Raut, R.S., Thokale, J.G. and Mehtre, S.S.. Effect of fertilizer and spacing on interspecific hybrid Phule 388 under summer irrigated condition. *J. Cotton Res. Dev*. **19(2):** 200-201 (2005).
23. Reddy, P., Raghu Rami and Gopinath, M. Influence of fertilizers and plant geometry on performance of *Bt* cotton hybrid. *J. Cotton Res. Dev*. **22(1):** 78-80 (2008).
24. Reddy, R.R.P. and Kumar, D.B. Yield and economics of *Bt* cotton as influenced by spacing and nutritional levels. *PKV Res. J.* **34(1):** 20-22 (2010).
25. Sawan, Z.M., Mahmoud, M.H. and Fahmy, A.H. Cotton (*Gossypium barbadense* L.) yield and fiber properties as affected by plant growth retardants and plant density. *J. Crop Improvement*. **21:** 171-189 (2008).
26. Singh, A., Rathore, P., and Pathak, D. Effect of foliar application of inorganic nutrients on yield of American cotton. *J. Cotton Res. Dev*. **19(1):** 169-171 (2004).
27. Srinivasulu, K, Hema, K., Prasad, N.V.V.S.D. and Krishna Rao, K.V. Performance of cotton hybrids under different spacings and nitrogen levels in black cotton soils of Costal Andhra Pradesh. *J. Cotton Res. Dev*. **20(1):** 99-101(2006).
28. Tayade, A.S., The response of *Bt* and non-*Bt* cotton hybrids to nutrient and pest management. Ph. D. Thesis (Un pub.) submitted to Marathwada Agriculture University, Parbhani (2007).
29. Venugopalan, M.V., Kranthi, K.R., Blaise, D., Lakde, S. and Shankaranarayanan, K. High density planting system in cotton-The Brazil Experience and Indian Initiatives. *Cotton Res. J*. **5(2):** 172- 185 (2013).
30. Waikar, S.L., Dhamak, A.L., Meshram, N.A. and Patil, V.D. Effect of speciality fertilizers on soil fertility, nutrient uptake, quality and productivity of cotton in vertisol. *J. Agric. and Veterinary Sci.* **8(2):** 76-79 (2015).