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Parmar RM
Agricultural school, B/H Bus station, Halvad (Dist-Morbi), Junagadh Agricultural University, Halvad, Gujarat, India

Parmar KB
Agricultural school, B/H Bus station, Halvad (Dist-Morbi), Junagadh Agricultural University, Halvad, Gujarat, India

Jadeja AS
Agricultural school, B/H Bus station, Halvad (Dist-Morbi), Junagadh Agricultural University, Halvad, Gujarat, India

Correspondence
Parmar RM
Agricultural school, B/H Bus station, Halvad (Dist-Morbi), Junagadh Agricultural University, Halvad, Gujarat, India

Effect of integrated nutrient management on quality parameters of *Bt.* Cotton (*Gossypium hirsutum* L.) Under north-west agro climatic zone of Gujarat

Parmar RM, Parmar KB and Jadeja AS

Abstract
A field experiment entitled "Integrated Nutrient Management in *Bt.* Cotton (*Gossypium hirsutum* L.) Under North-West Agro-Climatic Zone of Gujarat" was conducted during *Kharif* season of 2015-16 and 2016-17 at the Agricultural School Farm, Junagadh Agricultural University, Halvad. The Twelve different treatments combinations comprising of organic and inorganic fertilizers (NPK), FYM, *Azotobactor*, PSB and KSB were studied with thrice replication. Different integrated fertilization treatments had exerted their significant effect on quality parameters like, ginning percentage (%), fibre characters like, fibre fineness (mv), fibre strength (g tex^{-1}), staple length (mm), SFI and oil content (%) was recorded significantly higher with treatment T_9 *i.e.*100 % RDF + FYM 10 t ha^{-1} + *Azotobactor* 10 ml kg^{-1}seed + PSB 10 ml kg^{-1} seed + KSB 10 ml kg^{-1} seed with value of (39.54, 39.38, 39.46 %), (5.41, 5.33, 5.37 mv), (29.33, 29.77, 29.55 g tex^{-1}), (28.15, 28.16, 28.15 mm), (9.67, 9.63, 9.65) and (20.92, 20.92, 20.92 %) respectively. Significantly lowest quality parameter, ginning percentage (%), fibre characters like, fibre fineness (mv), fibre strength (g tex^{-1}), staple length (mm), SFI and oil content (%) of cotton were registered with treatment T_4 during both the years as well as in pooled results.

Keywords: cotton, INM, azotobactor, yield

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) [1, 6]. 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) [4]. The cotton (*Gossypium hirsutum* L.), an important fibre crop, is grown throughout India under both rainfed and irrigated conditions on an area of 118.72 lakh ha and production 30.15 lakh bales with a yield of 432 kg ha^{-1} during 2016-17 (Anon., 2017) [2].

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. Primarily Integrated Nutrient Management (INM) refers to combine old and modern method of nutrient management into ecologically sound and economically optimal farming that uses the benefits from all possible sources of organic, inorganic and biological components/substances in a judicious, efficient and integrated manner (Janssen, 1993) [7]. It optimizes all aspects of nutrient cycling including N, P, K and other macro and micro nutrient inputs and outputs, with the aims of synchronizing nutrient demand by the crop and its release in the environment. 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) [12]. 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) [3]. 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. Integration of organic manures with fertilizers has been traditionally important inputs in crop production for the maintenance of soil fertility and yield stability.

Materials and Methods

The experiment was conducted at Agricultural School Farm, Junagadh Agricultural University, Halvad during *kharif* season of 2015-16 and 2016-17. The soils of the field were sandy loam with slight alkaline in reaction. From the fertility point of view, these soils were moderately supplied with organic carbon 6.9 & 6.3 g kg^{-1}, low in available nitrogen 223& 240 $kgha^{-1}$, medium in phosphorus 29& 28 $kgha^{-1}$, potassium260 & 281 $kgha^{-1}$, sulphur 14.32 & 15.68 mg kg^{-1}, medium in Fe 5.48 & 7.32 mg kg^{-1}, Zn 0.68 & 0.58 mg kg^{-1}, and high in Mn 17.86 & 14.22 mg kg^{-1} and Cu 1.05 & 1.65 mg kg^{-1} during year 2015 and 2016, respectively. The experiment comprised of twelve treatments *viz.*, T_1-100 % RDF *i.e.* 240:50:150 – N: P_2O_5: K_2O kg ha^{-1}, T_2-75 % RD N + Full PK + *Azotobactor* 10 ml kg^{-1} seed, T_3-75 % RD P + Full K + PSB 10 ml kg^{-1} seed, T_4-75 % RDK + KSB 10 ml kg^{-1} seed, T_5-75 % RDF + *Azotobactor* 10 ml kg^{-1} seed + PSB 10 ml kg^{-1} seed + KSB 10 ml kg^{-1} seed, T_6-75 % RDF + FYM 10 t ha^{-1}**,** T_7-75 %RDF + FYM 10 t ha^{-1} + *Azotobactor* 10 ml kg^{-1} seed + PSB 10 ml kg^{-1} seed + KSB 10 ml kg^{-1} seed, T_8-100 % RDF + *Azotobactor* 10 ml kg^{-1} seed + PSB 10 ml kg^{-1} seed + KSB 10 ml kg^{-1} seed, T_9-100 % RDF + FYM 10 t ha^{-1} + *Azotobactor* 10 ml kg^{-1} seed + PSB 10 ml kg^{-1} seed + KSB 10 ml kg^{-1} seed, T_{10}-100 % RDF + FYM 10 t ha^{-1}, T_{11}-50 % RD P + Full NK + FYM 10 t ha^{-1} and T_{12}- N: K_2O as per targeted yield equations (236-0-149 and 210-0-110, N-P-K in 2015 and 2016, respectively), respectively. The nutrients of N, P, and K were applied by using sources of Urea, DAP and MOP. The cotton variety "G.Cot.Hy.8 (BG-II)" was planted in 16-06-2015 and 25-06-2016 during both the year with spacing of 120 m × 45 m and seed rate of 4 kg ha^{-1}. The crop was raised with all the standard package of practices and protection measures also timely carried out as they required. The experimental data recorded for yield attributes and yield parameters were statistically analyzed for level of significance.

Results and Discussion

Quality parameters

Effect of INM

Application of 100 % RDF (240:50:150 kg ha^{-1}) + FYM 10 t ha^{-1} + *Azotobactor* 10 ml kg^{-1} seed + PSB 10 ml kg^{-1} seed + KSB 10 ml kg^{-1} seed (T_9) to cotton crop registered significantly highest ginning percentage of 39.54, 39.38 and 39.46 % during both the years and in pooled data (Table 1) which was remain statistically at par with treatments T_7 and significantly lowest ginning percentage (35.15, 34.94 and 35.05 %) were recorded under treatment T_4 during both the years and in pooled results, respectively.

The data pertaining to fibre fineness as affected by different treatments practices are furnished in Table 1. Significantly the highest fibre fineness of 5.41, 5.33 and 5.37 µ was noticed during both the years and in pooled data results with the treatment T_9 of 100 % RDF (240:50:150 kg ha^{-1}) + FYM 10 t ha^{-1} + *Azotobactor* 10 ml kg^{-1} seed + PSB 10 ml kg^{-1} seed + KSB 10 ml kg^{-1} seed. Significantly lowest fibre fineness of 4.44, 4.35 and 4.39 µ was recorded during both the years and in pooled results under treatment T_4.

Perusal of data on fibre strength in Table 1 revealed that significantly maximum fibre strength (29.33, 29.77, and 29.55 g tex^{-1}) were noticed under treatment T_9 i.e. 100 % RDF (240:50:150 kg ha^{-1}) + FYM 10 t ha^{-1} + *Azotobactor* 10 ml kg^{-1} seed + PSB 10 ml kg^{-1} seed + KSB 10 ml kg^{-1} seed during both the years as well as in pooled results and it was at par with treatment T_6, T_7, T_{10}, and T_{11} during both the years and in pooled results. The treatment T_4 registered significantly lowest fibre strength of 25.27 g tex^{-1} in 2015 and 25.39 g tex^{-1} in pooled results but it was lowest (25.37 g tex^{-1}) with T_3 during 2016.

Application of 100 % RDF (240:50:150 kg ha^{-1}) + FYM 10 t ha^{-1} +*Azotobactor* 10 ml kg^{-1} seed + PSB 10 ml kg^{-1} seed + KSB 10 ml kg^{-1} seed (T_9) to cotton crop registered significantly highest staple length of 28.15, 28.16 and 28.15 mm during both the years and in pooled results (Table 2) which was remain statistically at par with treatment T_6, T_7, T_8, T_{10}, and T_{11} during the both the years and T_6, T_7, and T_{10} in pooled results, respectively. Significantly lowest staple length of 26.49, 26.40, 26.45 mm in 2015, 2016 and in pooled results respectively were recorded under treatment T_4.

Significantly the highest SFI of 9.67, 9.63 and 9.65 (Table 2) was noticed with the treatment T_9 100 % RDF (240:50:150 kg ha^{-1}) + FYM 10 t ha^{-1} + *Azotobactor* 10 ml kg^{-1} seed + PSB 10 ml kg^{-1} seed + KSB 10 ml kg^{-1} seed during both the years and in pooled results which was statistically at par with treatments T_7 and T_{10} in 2015, T_7, T_{10} in 2016 and treatment T_7 in pooled results. Significantly lowest SFI of 6.53, 6.51, 6.52 were recorded in 2015, 2016 and in pooled results under treatment T_4 *i.e.* 75 % RDK + KSB 10 ml kg^{-1} seed.

Perusal of data on oil content in Table 2 revealed that significantly maximum oil content (20.88, 20.92 and 20.90 %) was noticed under treatment T_9 i.e. 100 % RDF (240:50:150 kg ha^{-1}) + FYM 10 t ha^{-1} + *Azotobactor* 10 ml kg^{-1} seed + PSB 10 ml kg^{-1} seed + KSB 10 ml kg^{-1} seed in both the years and in pooled results. It was at par with treatments T_7 and T_{10} in during 2015 and 2016, respectively and T_7 is only pooled results. The treatment T_4 registered significantly lowest oil content (18.26, 18.32 and 18.29 %) during both the years and in pooled results. Increase in quality parameters in *Bt.* cotton could be due to limited supply of K during active fibre growth period may cause reduction in the turgor pressure of the fibre, resulting in less cell elongation and shorter fibers at maturity (Oosterhuis, 1994) [10], Similar findings pertaining to ginning percentage was earlier reported by Minton and Ebelhar (1991) [9], Sarkar and Majumdar (2002) [11], Vadariya (2011) [13], Dhale *et al*. (2011) [5] and Laxman (2015) [8].

Table 1: Effect of integrated nutrient management on Ginning percentage, fibre fineness and fibre strength of *Bt*. cotton

Treatments	Ginning percentage (%)			fibre fineness (micron)			Fibre strength (g tex^{-1})		
	2015	2016	Pooled	2015	2016	Pooled	2015	2016	Pooled
T_1	35.45	36.03	35.74	4.54	4.66	4.60	25.57	26.73	26.15
T_2	35.42	35.92	35.67	4.50	4.57	4.53	26.53	26.40	26.47
T_3	35.19	35.03	35.11	4.46	4.40	4.43	25.40	25.37	25.39
T_4	35.15	34.94	35.05	4.44	4.35	4.39	25.27	26.33	25.80
T_5	36.11	36.78	36.44	4.61	4.64	4.62	27.50	27.50	27.50
T_6	37.24	37.02	37.13	4.75	4.72	4.73	29.03	29.00	29.02
T_7	38.89	38.24	38.57	4.88	4.81	4.84	29.20	29.43	29.32
T_8	36.36	36.90	36.63	4.67	4.56	4.62	27.77	27.93	27.85
T_9	39.54	39.38	39.46	5.41	5.33	5.37	29.33	29.77	29.55
T_{10}	37.42	37.57	37.50	4.76	4.75	4.76	29.13	29.30	29.22
T_{11}	37.06	37.00	37.03	4.73	4.67	4.70	28.70	28.70	28.70
T_{12}	35.22	35.18	35.20	4.53	4.64	4.58	26.30	26.50	26.40
S.Em.±	0.59	0.53	0.40	0.13	0.09	0.08	0.47	0.49	0.34
C.D. at 5 %	1.73	1.56	1.13	0.39	0.26	0.23	1.37	1.44	0.97
C.V. %	2.79	2.51	2.65	4.93	3.23	4.17	2.94	3.07	3.01

Table 2: Effect of integrated nutrient management on staple length, SFI and oil content of *Bt.* Cotton

Treatments	Staple length (mm)			SFI (short fibre index)			Oil content (%)		
	2015	2016	Pooled	2015	2016	Pooled	2015	2016	Pooled
T_1	27.09	27.00	27.05	7.60	7.60	7.60	18.58	18.51	18.54
T_2	26.78	26.95	26.86	7.27	7.23	7.25	18.50	18.50	18.50
T_3	26.49	26.51	26.50	6.70	6.98	6.84	18.29	18.43	18.36
T_4	26.49	26.40	26.45	6.53	6.51	6.52	18.26	18.32	18.29
T_5	27.14	27.24	27.19	7.97	8.11	8.04	18.68	18.63	18.66
T_6	27.44	27.55	27.50	8.67	9.07	8.87	20.12	19.87	20.00
T_7	27.75	28.13	27.94	9.37	9.27	9.32	20.77	20.53	20.65
T_8	27.22	27.35	27.28	8.00	8.10	8.05	19.26	19.52	19.39
T_9	28.15	28.16	28.15	9.67	9.63	9.65	20.88	20.92	20.90
T_{10}	27.44	27.65	27.54	9.20	9.07	9.13	20.22	20.40	20.31
T_{11}	27.37	27.40	27.38	8.03	8.13	8.08	19.50	19.57	19.54
T_{12}	26.88	26.93	26.90	7.50	7.17	7.33	18.45	18.48	18.47
S.Em.±	0.32	0.32	0.23	0.23	0.24	0.17	0.24	0.28	0.18
C.D. at 5 %	0.93	0.95	0.65	0.67	0.71	0.47	0.71	0.82	0.53
C.V. %	2.01	2.06	2.04	4.90	5.18	5.04	2.18	2.50	2.34

Conclusion

On the basis of two years experimentation, the application of 100 % RDF (240:50:150 kg ha^{-1}) + FYM 10 t ha^{-1} + *Azotobactor* 10 ml kg^{-1} seed + PSB 10 ml kg^{-1} seed + KSB 10 ml kg^{-1} seed (T_9) exhibited its superiority in respect of the quality parameters like Ginning percentage, fibre fineness, fibre strength, staple length, SFI and Oil content in sandy loam soil under North-West Agro-climatic Zone of Gujarat.

Overall, the application of organic (FYM), inorganic (NPK) fertilizer and bio fertilizers (*Azotobacter*, PSB and KSB) in integration plays an offensive role in improving quality.

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