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Effect of site specific nutrient management on yield of cotton, yield attributes and availability of nutrients in Vertisols

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Abstract
Site-Specific Nutrient Management (SSNM) aims at balanced nutrient application to crops based on the nutrient requirement to produce a unit quantity of yield taking in to account the native nutrient supplying capacity of soil. The experiment was carried out at farmers' fields in different village's in Akola district during kharif seasons of 2014-15 and 2015-16 on Vertisols. The trial consists of four treatments of nutrient application *viz.* omission of nitrogen (-N), omission of phosphorus(-P), omission of potassium (-K) and Ample NPK. The treatment wise number of boll, boll weight and seed cotton yield was recorded during both the years. The data indicated that the magnitude of increase in seed cotton yield due to balanced application of NPK as per SSNM was recorded higher significantly. Omission of N, omission of P, and omission of K recorded 18.02%, 10.10% and 13.32% lower seed cotton yield as to compared to NPK treatment. The higher number of boll, boll weight registered similar trend. The available nitrogen phosphorus and potassium in soil after harvest of cotton were recorded significantly higher in balanced nutrient treatment as compared to omission of N, P and K treatments. Hence, it is concluded that balanced nutrient application through SSNM enhanced the cotton productivity and availability of nutrients over omission of nutrients.

Keywords: Seed cotton yield, Nutrient uptake, Vertisols, SSNM

Introduction
Plants require nutrients for growth and development. Plants absorb nutrients from soil, water and air. Indian soils are generally deficient in Nitrogen, phosphorus and micronutrients. A deficiency of nutrients drastically affects growth, metabolism and reproductive phase in plants. To fulfill the deficiencies of nutrients in soil the application of fertilizers is essential. The key factor behind high yield and growth could be the development of new technology that will produce higher yields. In these context, fertilizers play a key factor in this task. The soil have native nutrients which needs to taken into account for application of nutrients from fertilizers. The farmers also use organic manures before sowing of crops, considering these situation fertilizer application should be in optimum quantity to meet nutrient requirement of crops so as to achieve the set yield target.

Cotton is an important cash as well as fibre crop and play vital role in the history and civilization of mankind, with enormous potential in textile industries and is a means of livelihood for millions of farmers and those concerned with its trade, processing, manufacturing and other allied industries. No agricultural commodity in the world exercised a profound influence on economy as cotton from the time immemorial.

The use of external inputs hitherto has driven the crop productivity gains in India but in future, there is need to focus on knowledge intensive technologies and adoption of the same on individual farms. In this context, Site- Specific Nutrient Management (SSNM) approach is one such option which focuses on balanced and crop need-based nutrient application (Johnston *et al*., 2009) [8]. The dissemination of such technologies would go long way in improving the productivity and profitability of farming. Balanced nutrition of major plant nutrients and micronutrients based on soil test ensures efficient use of both applied and soil available nutrients and helps in sustaining the soil productivity. Long term nutrient management research on several crops indicated that balanced nutrition with all major, secondary and micro nutrients is essential for sustained higher yield levels. Site-Specific Nutrient Management (SSNM) is a tool which intends for balanced precision nutrition of N, P and K along with secondary and micronutrients based on the nutrient supplying capacity of the soil, the nutrient requirement of a particular crop to produce a unit quantity of yield or set yield target. Gill *et al.* (2008) [5] opined that by adopting the principles of SSNM in India the present food grain

production could be achieved from half of the current irrigated area and rest could be better utilized in crop diversification efforts in view of this the present investigation was carried out to study the effect of site specific nutrients managements on seed cotton yield, yield attributes and nutrients availability.

2. Material and Methods

A field experiments on cotton was conducted during kharif seasons of years 2014-15 and 2015-16 on the farmer field in Akola district. The mean annual rainfall is about 719 mm, of which nearly 80% is received during the monsoon period extending from July to September and the rest during the period between October and December. The sites were selected having similar soil characteristics with medium to deep black soils. The initial composit soil samples from each sites were collected processed and analyzed for soil properties namely pH, EC, OC, available N, P and K. The soils were grouped as Vertisols. Soil of experimental site was moderately alkaline in reaction (8.21), medium in organic carbon content (5.75 g kg^{-1}). The soils were low in nitrogen (180.5 kg ha^{-1}), medium in phosphorus (15.05 kg ha^{-1}) and very high in potassium (422.35 kg ha^{-1}).

The treatment wise surface (0-20 cm) soil samples were collected at harvest of cotton at all sites. The soil sample were mixed thoroughly to make composite representative sample, dried in shade, passed through 2 mm sieve diameter and used for further analyzed for soil physical and chemical properties. These sieved samples were further passed through 0.5 mm sieve for estimation of organic carbon. Available nitrogen in soil was determined by alkaline potassium permanganate method using microprocessor based automatic distillation system. For available P, soil samples were extracted with 0.5 M $NaHCO_3$ (pH=8.5) and P content in the extracts was determined using spectrophotometer (Jackson, 1973) [7]. Available potassium was determined by extracting soil with neutral (1N) ammonium acetate (pH 7) solution and readings were recorded using Flame photometer (Jackson, 1973) [7].

The four treatments viz, N omission and ample PK, P omission and ample NK, K omission and ample NP and ample NPK**,** laid out in Randomized Block Design at fifteen locations. Each site was considered as one replication. The four treatments were randomly assigned at each location. Bt cotton variety was same at each site and sown at 120 cm x 30 cm spacing**.** The rate of N, P_2O_5 K_2O was 160:70:80 kg ha^{-1} cotton. Full dose of P was applied as basal and nitrogen was applied in three splits, 1/3rd basal and remaining 1/3rd after 30 days after sowing (DAS) and 1/3rd after 60 DAS. Potassium was applied in two splits, 50 per cent as basal and 50 per cent after 60 DAS.

3. Results

The seed cotton yield during 2014-15 ranged from 16.37 to 20.29 q ha^{-1} and during second year study it varied to from 20.32 to 24.39 q ha^{-1} while mean seed cotton yield varied from 18.34 to 22.37 q ha^{-1}. The seed cotton yield influenced significantly during both the years. The significantly highest seed cotton yield (22.37 q ha^{-1}) was recorded in combined application of NPK in ample quantity as compared to other treatments of N, P and K omission. The lowest seed cotton yield (18.34 q ha^{-1}) was registered in in N omission treatment (Table 1 and Fig 1). This could be attributes to balanced nutrition in ample quantity and native nutrients available in soil. Similar trend was noticed during both year of study. It noticed that, the seed cotton yield highly influenced by nitrogen omission (18.02 per cent yield reduction), followed by potassium omission (13.32 per cent yield reduction). Similar finding were reported by Biradar *et al.,* (2011) [4], Ashaq Hussain *et al.* (2013) [1]. Katkar *et al.,* (2002) [9] reported that the application of RDF (50:25:00 N, P_2O_5 and K_2O kg ha^{-1}) recorded higher seed cotton yield over control under rainfed condition.

The stalk yield during 2014-15 ranged from 35.21 to 39.08 q ha^{-1} and during second year study, it varied to from 43.64 to 49.84 q ha^{-1} while mean seed cotton yield varied from 39.43 to 44.51 q ha^{-1}. The highest stalk yield (44.51 q ha^{-1}) was observed in NPK treatment and followed similar trend. The highest seed cotton yield could be ascribed balanced nutrient supply to crop. The balance d NPK treatment recorded 50.97%, 61.20% and 11.11% higher seed yield only than PK, NK and NP treatment, respectively. The highest seed cotton yield was observed in NPK treatment could be ascribed due to higher number boll and higher boll weight as compared to that of PK, NK and NP treatment. The reduction in the yield due to K omission ranged from 12-14 per cent, signifying the importance K nutrition in cotton production. Yield loss to the tune of 20 per cent due K omission has been reported by Bhalerao and Gaikwad (2010) [3]. The main reason for higher growth and yield components balance fertilization due to higher doses of nitrogen be attributed to the vital role of it in cell division and cell elongation. Potassium had significant effect on improving the resistance capacity of the crop to drought and alleviates the negative effects of water functioning as the main osmotic solute in plants. Hussian *et al*., (2011) [6] reported that N is the most limiting nutrient and its omission resulted in drastic reductions in seed cotton yield.

Table 2: Effect of nutrient management on seed and stalk yield of cotton

Treatment	Seed yield (q ha^{-1})			Stalk yield (q ha^{-1})		
	2014-15	2015-16	Mean	2014-15	2015-16	Mean
T_1: (-N) and PK	16.37	20.32	18.34	30.81	41.71	36.14
T_2: (-P) and NK	18.57	21.69	20.11	35.62	45.98	40.75
T_3: (-K) and NP	17.22	21.56	19.39	35.21	43.64	39.43
T_4: (NPK)	20.29	24.39	22.37	39.08	49.84	44.51
SE (m)±	0.14	0.22	0.14	0.33	1.07	0.50
CD at 5%	0.41	0.62	0.40	0.93	3.04	1.42

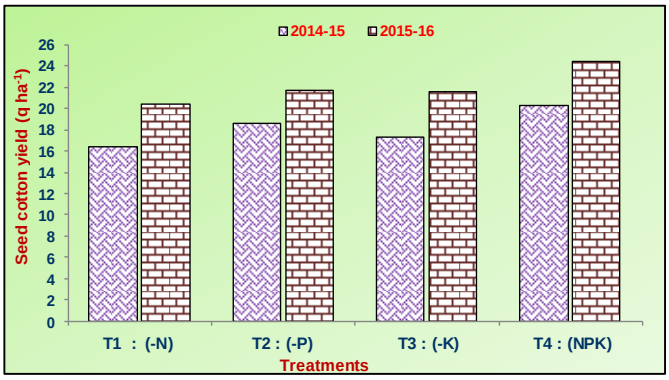

Fig 1: Seed cotton yield as influenced by nutrient management Yield attributes

The significantly highest number of boll (25.44) and boll weight (4.13 g) were noticed in the NPK treatments as compared to other treatments (Table 2). During both the years

of study, highest number of bolls found under the treatment receiving conjoint use of nutrient in ample quantity of NPK which was significantly superior over the all treatments. The significantly highest boll weight (4.13 g) was registered in the treatment receiving combined use of nutrient in ample quantity while the lowest boll weight (3.57 g) was noticed in treatment of only P and K applied and omission of N.

The imbalanced nutrition in N, P and K omission treatments recorded in reduction the number of bolls and boll weight significantly. The decrease in number of boll and boll weight could be attributed to imbalanced nutrient application to cotton crop. The lowest number of bolls and boll weight registered in nitrogen omission treatments followed by K omission treatments. The higher growth and yield attributes could be balance due to higher dose of balanced nutrition which play to the vital role of it in cell division and cell elongation.

Table 2: Effect of nutrient management on yield attributing character of cotton

Treatment	No. of bolls / plant			Boll weight (g)		
	2014-15	2015-16	Mean	2014-15	2015-16	Mean
T_1 : (-N) and PK	19.72	20.81	20.27	3.81	3.34	3.57
T_2 : (-P) and NK	21.59	23.77	22.68	3.98	3.61	3.79
T_3 : (-K) and NP	20.31	22.98	21.64	3.90	3.49	3.69
T_4 : (NPK)	23.02	27.88	25.44	4.07	4.19	4.13
SE (m)±	0.19	0.87	0.44	0.023	0.06	0.03
CD at 5%	0.56	2.48	1.26	0.070	0.17	0.10

Potassium had significant effect on improving the resistance capacity of the crop to drought and alleviates the negative effects of water functioning as the main osmotic solute in plants the findings reported by Basavanneppa and Biradar (2002) [2].

Available nutrients in soil

The significantly highest available of nitrogen (233.93 kg ha^{-1}) was observed under combined use of fertilizer NPK followed by omission treatments while the lowest available nitrogen recorded in omission of nitrogen (171.45 kg ha^{-1}). The omission of nitrogen, phosphorus and potassium from the nutrient dose showed 26.7 , 8.41 and 9.74 per cent reduction in available nitrogen as compared to balanced application of nutrients (Table 3). This might be due to imbalanced nutrient application.

The significantly highest available phosphorus was recorded under the balanced dose fertilizer NPK (21.79 kg ha^{-1}) which was significantly superior over rest of the treatments followed by omission of potassium. The lowest availability of phosphorus in soil (16.41 kg ha^{-1}) was found in the treatment of P omission where only N and K was applied. This could be attributed to omission P, from nutrition.

Table 3: Effect of nutrient management on available nutrients in soil at harvest of cotton

Treatment	Available nutrients (kg ha^{-1})								
	N			P_2O_5			K_2O		
	2014-15	2015-16	Mean	2014-15	2015-16	Mean	2014-15	2015-16	Mean
T_1 : (-N) and PK	213.13	192.33	171.45	16.19	23.52	19.86	468.1	421.7	444.97
T_2 : (-P) and NK	251.55	249.74	214.25	13.93	19.18	16.41	468.3	412.1	440.25
T_3 : (-K) and NP	245.16	248.65	211.14	16.20	23.89	20.04	420.3	389.8	405.14
T_4 : (NPK)	272.46	267.15	233.93	16.92	26.66	21.79	490.5	430.9	460.74
SE (m)±	0.74	5.17	3.06	0.22	0.57	0.31	4.37	1.56	1.92
CD at 5%	2.12	14.74	8.74	0.62	1.61	0.89	19.74	4.44	5.48

The significantly highest available potassium was observed with the application of combined NPK (460.74 kg ha^{-1}) over rest of the treatments. The lowest availability of potassium (405.14 kg ha^{-1}) was observed under potassium omission treatments. Mandal *et.al*. (2002) [10]. also reported significantly higher available of N, P, K was found in recommended dose of NPK compared with other omission treatment. Similar findings also noticed Rajan Raja *et al*. (2001) [11].

Conclusions

The magnitude of increase in the seed cotton yields in site specific nutrient management with balanced nutrition over omission treatments suggest that there is wide scope to enhance the productivity of cotton substantially through improvement in the nutrient management. From the study it can be concluded that seed yield of cotton and yield attributes enhanced with site specific nutrient management with balanced application of N, P, K over omission of nutrients.

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