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Effect of Speciality Fertilizers on Soil Fertility, Nutrient Uptake, Quality and Productivity of Cotton in Vertisol

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Abstract: *A field experiment was conducted during the year 2011-2012 to study on effect of speciality fertilizers on soil fertility, nutrient uptake, quality and yield of cotton in Vertisol. The treatment combination of 100 % RDF + two spray of starter and booster showed higher availability of N, P and K. Application of 100% RDF + Grade II was noted higher availability of micronutrients (Zn, Fe, Mn and Cu) as compare to the other treatments. In contrast to concentrations of N, P and K were recorded maximum with treatment T_5 (100% RDF + two spray of starter and booster) in cotton plant. However, micronutrient concentrations in cotton plant were significantly increased with treatment T_{10} (100% RDF + Grade II) towards 100% RDF + two spray of starter and booster (T_5). Higher uptake of NPK and micronutrients (Zn, Fe, Mn and Cu) were noticed with 100 % RDF and two spray of each starter and booster than other treatments. Although, application of 100% RDF + two spray of starter and booster (T_5) was significantly increased in seed cotton yield, oil and protein content in cotton seed.*

Keywords: *Speciality fertilizers, protein, oil, Zn, Fe, Mn, Cu.*

I. Introduction

Cotton (Gossypium species) enjoys a pre-eminent status among all the commercial crops in the country, being the principal raw material for flourishing textile industry. In India, in spite of several competitions from synthetic fibers in recent years, it is occupying a premiere position with 70 per cent share in the textile industry. Foliar Fertilizer has the advantages of low cost and a quick plant response, and it is particularly important when soil problems occur and root growth is inadequate. On the other hand, it has disadvantages of possible foliar burn, solubility problems, and only a small amount of the nutrient can be applied at any one time. Cotton removes good amounts of plant nutrients from the soil. The choice of appropriate nutrient management and crop rotation determines the efficiency of nutrients. Variable yield responses to foliar fertilization have been reported. Therefore, attention also needs to be given to the ideal method and timing for incorporation of foliar fertilization into existing production practices.

II. Material And Methods

A field experiment was conducted at research farm, Department of Soil Science and Agricultural Chemistry, VNMKV, Parbhani (MS) during kharif season 2012-12 with cotton crop on Vertisol. The experiment was laid out in Randomized Block Design (RBD) with 10 treatments and replicated in trice. The experimental soil was slightly alkaline in reaction having pH 8.1, medium in organic carbon 2.9 g kg^{-1}, non calcareous in nature ($CaCO_3$-2.30 g kg^{-1}), low in available N-123.29 kg ha^{-1} and P-2.20 kg ha^{-1} and high in available K-495.28 kg ha^{-1} and sufficient in available micronutrients (Zn-0.38, Fe-2.60, Mn-7.55 and Cu-2.01 mg kg^{-1}). Soil samples were collected randomly from 0-15 cm depth and mixed thoroughly and finally a composite sample was obtained. The sample was brought to laboratory air dried, ground to passed through < 2 mm sieve. The representative sample was analyzed for chemical properties viz. OC, $CaCO_3$, NPK by using standard procedure (Jackson, 1973). DTPA extractable micronutrients (Zn, Fe, Mn and Cu) were determined as per the method described by Lindsay and Norvell (1978). Oven dried plant samples 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. (2005). The nutrient uptake was worked out by multiplying the nutrient concentration in plant/grain with dry matter yield dividing by 100. The data was subjected to statistical analysis by the method described by Panse and Sukhatme (1985).

III. Result And Discussion

Organic carbon and Calcium carbonate: The initial organic carbon content in soil was 2.9 g kg^{-1} mainly from before sowing of cotton. The result clearly indicated that the maximum (4.7 g kg^{-1}) organic carbon was noticed with application of T_5 (100% two spray of starter) as compare to other treatments and its initial value. In contrast to $CaCO_3$ content in soil was recoded statistically non-significant but it was varied from 2.40 to 3.82 % (Table 1).

Available NPK and micronutrients (Zn, Fe, Mn and Cu): The data pertaining to Table 1 clearly indicated that the initial available N of soil was 123.29 kg ha^{-1}. After harvest of cotton, it was noticed higher (153.24 kg ha^{-1}) receiving T_5 (100% two spray of starter) over all the

Table 1. Effect of speciality fertilizers on available nutrients after harvest of cotton.

Treatment	Organic carbon (g kg^{-1})	Calcium carbonate (%)	Avail. N (kg ha^{-1})	Avail. P (kg ha^{-1})	Avail. K (kg ha^{-1})	DTPA-Zn (mg kg^{-1})	DTPA-Fe (mg kg^{-1})	DTPA-Mn (mg kg^{-1})	DTPA-Cu (mg kg^{-1})
T_1- Control	2.9	2.40	115.27	2.25	510.21	0.39	2.70	7.68	2.08
T_2- RDF 120:60:60:20 NPKS kg ha^{-1}	3.6	2.68	125.26	2.88	603.52	0.42	2.73	8.01	2.11
T_3-100%RDF + water spray	4.0	2.76	128.15	3.25	620.20	0.41	2.82	8.88	2.42
T_4-100% RDF + one spray of starter and booster	4.3	3.20	144.21	4.10	764.73	0.55	3.04	10.53	3.48
T_5- 100% two spray of starter and booster	4.7	3.82	153.24	4.60	787.43	0.57	3.07	11.48	3.54
T_6-80% RDF +One spray of starter and booster	3.7	3.21	139.06	3.70	722.27	0.40	2.97	10.23	3.24
T_7-80%RDF + two spray of starter and booster	4.2	3.43	145.28	3.55	741.41	0.55	3.00	10.41	3.37
T_8-60% RDF + one spray of starter and booster	3.2	3.03	134.21	3.87	690.13	0.41	2.87	9.28	3.20
T_9-60% RDF + two spray of starter and booster	3.3	3.07	133.91	4.05	681.30	0.43	2.93	10.23	3.16
T_{10}-Grade II	3.7	3.65	131.75	3.44	641.63	0.59	3.11	11.61	3.60
Mean	3.7	3.12	135.03	3.56	676.29	0.47	2.92	10.00	3.02
SE+	0.43	-	0.72	0.06	2.83	0.009	0.017	0.084	0.10
CD at 5%	1.31	-	2.13	0.18	8.40	0.027	0.050	0.250	0.31

Treatments and closely followed by treatment T_4 (144.21 kg ha^{-1}). However, control treatment T_1 (115.27 kg ha^{-1}) showed lowest value than other treatments. The foliar application N fertilizers gave numerically higher utilization of N by plant observed as well as in soil also. Regarding available phosphorus at harvesting stage similar trend was observed. Similar result was found by Sawan et al. (2006). In response to K availability, maximum K (787.43 kg ha^{-1}) was noted with applying T_5 (100% two spray spray of starter and booster) than other treatments. K increases the photosynthetic rates of crop leaves, CO_2 assimilating and facilitates carbon movement (Sangakkara et al. 2000). Also, K nutrition has pronounced effects on carbohydrates partitioning by affecting either phloem export of photosynthates (sucrose) or growth rate of sink and / or source organs (Cakmak et al. 1994). However, higher micronutrients (Zn, Fe & Mn) availability were noticed (0.57, 3.07, 11.48 mg kg^{-1}) in treatment receiving T_5 (100% two spray of starter and booster) at harvest stage of cotton as compare to the other treatment and its initial status. While, available copper in soil was found to be maximum in treatment T_{10} (3.60 mg kg^{-1}) followed by T_5 (3.54 mg kg^{-1}) receiving Grade II and 100% two spray of starter and booster and these treatments were found to be at par with each other.

NPK and micronutrients (Zn, Fe, Mn and Cu) concentration: The perusal data of NPK and micronutrients concentrations in cotton were detected significantly higher with the application of 100% two spray of starter and booster (T_5) and Grade II (T_{10}). Among the treatments (T_5) and (T_{10}) were found to be at par with each other and leading to better superiority as compare to other treatments. However, the reduction of major and micronutrient concentration were noticed in absolute control treatment (Table 3). The significant influenced of NPK and Zn, Fe, Mn and Cu concentration in cotton plant were observed by some of foliar application for cotton crop (Mehta et al. 2010; Bendarz et al. 1999; Dordas 2009).

Uptake of NPK and micronutrients (Zn, Fe, Mn and Cu): The data (Table 2) showed that maximum uptake of N was noticed with treatment T_5 (114.26 kg ha^{-1}) followed by treatment T_4 (104.51 kg ha^{-1}), while lowest uptake of N was noticed under control treatment T_1 (42.45 kg ha^{-1}). Further, as per variations in the treatments the uptake of N was decreased. Similar trends were recorded for uptake of P by cotton. Treatments T_5 (14.20 kg ha^{-1}) closely followed by treatment T_4 (13.10 kg ha^{-1}) which were found to be at par with each other. Further, the influenced of different treatment on uptake of N and P followed the order $T_5>T_4>T_7>T_6>T_9>T_8>T_{10}>T_3>T_2>T_1$. The uptake of potassium by cotton was maximum with treatment T_5 (89.40 kg ha^{-1}) followed by treatment T_4 (64.24 kg ha^{-1}) and these treatments were found to be at par with each other. Similar findings were conformably agreement with Sawan et al. (2008) he reported that integrated application of N, P and K in cotton crop.
In respect to micronutrient (Zn, Fe, Mn and Cu) uptake, uptake of Zn was noticed significantly superior with treatment T_5 (34.43 g ha^{-1}) followed with treatment T_{10} (27.51 g ha^{-1}). However, maximum uptake of Fe was

observed with treatment T_5 (203.95 g ha^{-1}) followed by treatment T_4 (199.58 g ha^{-1}). Further, treatment T_7 (195.76 g ha^{-1}), T_6 (192.90 g ha^{-1}), T_{10} (193.30 g ha^{-1}) and T_3 (173.07), T_2 (170.10 g ha^{-1}) were at par with itself. Uptake of Mn by cotton was noticed significantly higher with treatment T_5 (86.44 g ha^{-1}) followed by treatments T_{10} (82.97 g ha^{-1}), T_6 (69.66 g ha^{-1}) and T_7 (80.23 g ha^{-1}) and T_9 (65.99 g ha^{-1}), T_8 (63.13 g ha^{-1}), T_4 (60.84 g ha^{-1}), T_3 (29.06 g ha^{-1}), T_2 (52.69 g ha^{-1}) and T_1 (47.77 g ha^{-1}) which were found to be at par with each other. In addition to Cu uptake was noticed maximum with treatment T_5 (15.17 g ha^{-1}) and it was closely at par with treatments T_4 (13.41 g ha^{-1}) and T_{10} (14.72 g ha^{-1}). Also, the treatment T_3, T_6, T_7, T_8, and T_9 were found to be statistically at par with each other. The micronutrient uptake significantly increased with foliar spraying of different nutrient combinations and this could be due to higher dry matter production and higher seed cotton yield (Ishaq et al. 1992). Namdev et al (1992) observed the foliar spraying of 1% Micnelf (containing Zn, Cu, Fe, Mn, Mo and B) highest content and uptake of micronutrient.

Table 2. Effect of speciality fertilizers on uptake of macro and micro nutrients by cotton

Treatment	Uptake by cotton (kg ha^{-1})			Uptake by cotton ((g kg^{-1})			
	N	P	K	Zn	Fe	Mn	Cu
T_1- Control	42.45	3.80	34.54	20.84	158.99	47.77	9.46
T_2- RDF 120:60:60:20 NPKS kg ha^{-1}	52.25	4.53	37.14	21.84	170.10	52.69	9.89
T_3-100%RDF + water spray	57.19	5.72	40.16	23.76	173.07	59.06	11.55
T_4-100% RDF + one spray of starter and booster	104.51	13.10	64.24	32.14	199.58	60.84	13.86
T_5- 100% two spray of starter and booster	114.26	14.20	89.40	34.43	203.95	86.44	15.17
T_6-80% RDF +One spray of starter and booster	84.52	8.89	54.97	27.43	192.90	69.66	12.63
T_7-80%RDF + two spray of starter and booster	88.27	9.87	68.54	29.67	195.76	80.23	13.41
T_8-60% RDF + one spray of starter and booster	72.90	6.28	49.65	24.99	187.87	63.13	12.64
T_9-60% RDF + two spray of starter and booster	81.36	6.62	50.77	26.90	186.87	65.99	12.55
T_{10}-Grade II	68.19	5.47	45.36	33.78	193.30	82.97	14.72
Mean	76.59	7.84	53.47	27.51	186.22	66.87	12.55
SE+	0.007	0.013	0.006	0.01	1.05	6.63	0.62
CD at 5%	0.020	0.041	0.018	0.05	3.12	19.69	1.86

Table 3. Effect of speciality fertilizers on yield, protein, oil and nutrient content at harvest of cotton.

Treatment	Seed cotton yield (q ha^{-1})	Protein content (%)	Oil content in cotton seed (%)	Concentration (%)			Concentration (mg kg^{-1})			
				N	P	K	Zn	Fe	Mn	Cu
T_1- Control	9.58	20.22	18.3	1.45	0.13	1.18	31.50	240.3	72.2	14.3
T_2- RDF 120:60:60:20 NPKS kg ha^{-1}	12.80	20.47	18.7	1.73	0.15	1.23	32.00	249.2	77.2	14.5
T_3-100%RDF + water spray	13.37	20.67	19.4	1.88	0.17	1.32	34.60	251.7	85.9	16.8
T_4-100% RDF + one spray of starter and booster	24.38	22.21	22.30	3.27	0.41	2.01	44.50	276.3	113.3	19.2
T_5- 100% two spray of starter and booster	24.84	22.22	23.20	3.54	0.44	2.77	47.20	279.6	118.5	20.8
T_6-80% RDF +One spray of starter and booster	22.32	21.81	20.30	2.66	0.28	1.73	38.20	268.6	97.00	17.6
T_7-80%RDF + two spray of starter and booster	22.61	21.98	21.10	2.77	0.31	1.81	41.20	271.8	111.4	18.5
T_8-60% RDF + one spray of starter and booster	15.93	21.74	20.00	2.32	0.20	1.58	35.20	264.3	88.90	16.4
T_9-60% RDF + two spray of starter and booster	22.28	21.79	20.24	2.58	0.21	1.61	36.90	262.2	92.6	17.2
T_{10}-Grade II	15.26	22.24	22.40	2.24	0.18	1.49	49.10	285.8	120.6	21.4
Mean	18.33	21.53	20.60	2.44	0.24	1.67	39.04	264.3	97.76	17.6
SE+	1.29	0.006	0.50	0.08	0.003	0.019	0.83	17.66	0.25	0.49
CD at 5%	3.89	0.020	1.49	0.24	0.011	0.057	2.47	52.41	0.76	1.47

Seed cotton yield, oil and protein content in cotton seed: Higher yield of cotton was observed with treatment T_5 (24.84 q ha^{-1}) and T_4 (24.38 q ha^{-1}) receiving (100% two spray of starter & booster) and (100% RDF + one spray of starter and booster) which were statistically at par. In addition, treatments T_7, T_9, T_2, T_3, T_{10} and T_8 were at par with itself. The lowest yield of cotton was noticed under absolute control treatment T_1 (9.58 q ha^{-1}). The significant variation in cotton seed yield was due to foliar nutrition on yield recorded in this study in the line with the results reported by Nehra et al. (2003) and Dordas (2009). Although the higher oil content in cotton seed was noted with treatment T_5 (23.20%) and it was closely at par with treatment T_4 (22.30%) and T_{10} (22.40%). Also, the treatment T_9, T_8, T_2 and T_3 were found to be at par with each other. Further, control treatment T_1 (18.30) showed lowest value than other treatments. However, maximum protein content was noticed with treatment T_{10} (22.24%) followed by treatment T_5 (22.22%). While, treatment T_6 (21.81%) and

treatment T_9 (21.79%) were at par with each other. Further, as per variations in the treatments the protein content was decreased. However, lowest value was recorded with control treatment T_1 (20.22%) than other treatments (Table 3). Significantly improvement of oil and protein content in cotton seed by using foliar nutrition management as given by Sawan et al. (2006).

The whole information is given by, to gaining higher productivity, nutrient uptake as well as quality were significantly influenced by the application of 100% RDF + two spray of starter and booster (T_5) closely near with 100%RDF + Grade II (T_{10}) as compare to the other treatments. Among these treatments, treatment T_5 and T_{10} were found to be better nutrient supplied and beneficial in respect to build up of soil fertility, higher productivity, maximum nutrient uptake and quality produce from cotton grown in Vertisol.

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