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Soil fertility and on-farm crop response to NPK and Zn fertilization in rice-rice cropping sequence of Lower Brahmaputra Valley Zone of Assam

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ABSTRACT

Despite being a major source of livelihood, rice cultivation in the plains of the north-east region of India is under stress due to depletion of native nutrient reserves, emergence of multi-nutrient deficiencies and consequent decline in factor productivity of applied nutrients. With the aim to enhance productivity and to develop efficient fertilizer management strategies for the region, the authors discuss the status of post harvest soil properties and on-farm crop response to plant nutrients in rice-rice sequence under the climatic situation of Lower Brahmaputra Valley Zone of Assam. Results revealed that the recommended dose of NPK fertilizers along with 5 Kg $ZnSO_4$ application not only increases the yield of rice-rice sequence but also enhances the post harvest fertility status of soil.

Key Words: North-east India, Nutrient management, Rainfed situation, Soil properties.

INTRODUCTION

Rice, among all the cereals, is one of the most important food crop and a primary food source in India cultivated in a total area of 43.09 million hectares with a production of 106.30 million tonnes (Directorate of Economics & Statistics, 2013-14). This rice dominates the agriculture scenario in Assam of north-east region of India. In Assam, rice is cultivated in a wide range of environmental situations *i.e.* Autumn (*Ahu*), Winter (*Sali*), Summer (*Boro*) and Deep water (*Bao*) rice in 26.79 lakh hectare area, that produces around 55.00 lakh metric tonnes of rice, annually.

Rice, mono-cropping in Assam has allowed the field to remain under fallow for a considerable period of time, where at least a second crop is possible to grow. However, rice production under field condition has not been increased according to the genetic potential of varieties and thus, average yield of fine grain rice varieties are much below than its production potential. There are number of factors among which improper nutrient management is the key factor contributing to this yield gap.

Next to NPK nutrients, Zn is considered to be the most limiting micronutrient that affect the grain yield of rice in north-eastern part of India. Hence, there is no alternative than to use more plant nutrients for high productivity of rice (Ahmad, 1992). Application of fertilizers either in excess or less than optimum rate affect both yield and quality of rice to a remarkable extent, hence proper management of crop nutrition is of immense importance. Recent survey in the Lower Brahmaputra Valley Zone of Assam revealed that farmers apply greater than recommended rates of both nitrogen (N) and phosphorus (P), but ignore the replenishment of other nutrients. Such an imbalanced use of fertilizer not only aggravates the deficiency of other macro and micronutrients in the soil, but also proves uneconomical as well as environmentally unsafe. The high yield potential of modern varieties can never be exploited under this scenario. Since fertilizer is an expensive and precious input, determination of an appropriate dosage of application that would be economical and appropriate to enhance productivity and also profitable to the grower under given situation needs a intensive study.

There is very little information on soil changes and rice crop yields from on-farm crop response to plant nutrients in rice-rice cropping system more particularly from north-eastern part of India. Hence, the details of a study on on-farm assessment of nutrient management with Autumn rice-Summer rice cropping sequence in terms of soil fertility and yield of crops under rainfed situation of Lower Brahmaputra Valley Zone (LBVZ) of Assam is describe in this article.

MATERIALS AND METHODS

The field experiment was conducted during 2013-14 with Rice (pre-flood) – Rice (post-flood) cropping sequence under rainfed situation in the flood affected area of Assam. The experimental site was located in the Kamrup Rural district (situated in latitude 25°58'-26°02'N, longitude 91°03'-91°09'E and altitude 97 - 189 feet) of Lower

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Table 1: Soil characteristics before commencement of the sequence

Block name	Village name	WHC (%)	pH	OC (%)	EC (dS/m)	Available N (Kg/ha)	Available P_2O_5 (Kg/ha)	Available K_2O (Kg/ha)
Chamaria	Hekra	30.38	5.3	0.58	0.24	331.19	19.21	270.92
	Mondira	31.08	4.8	1.08	0.20	301.01	19.75	248.65
	Jogipara	31.55	4.9	1.04	0.19	310.45	23.01	256.52
Boko	Khatla	32.92	4.8	1.13	0.19	326.76	21.45	276.15
	Bhatipara	35.34	5.1	0.92	0.22	330.20	22.91	274.86
	Baniavita	35.55	4.9	1.15	0.19	298.46	21.28	230.80

Brahmaputra Valley Zone of Assam, India. Being situated in the Eastern Himalayan Region (Zone 2), the climate of the study area is characterised by abundant rainfall during *kharif* season (July-October) with hot & wet summer (March-June) and dry & cool winter (November-February). Mean maximum and minimum annual temperatures recorded were 27.5°C and 17.2°C, respectively. Lowest temperature was recorded in January, while the highest temperature in June. The general topography of the study area was plane.

Selections of sites were done within the Kamrup (Rural) district where 2 blocks *viz.* Chamaria and Boko were selected and from each block, 3 villages were selected randomly. Thus, Chamaria block included 3 villages *viz.* Hekra, Mondira and Jogipara where as Boko block included other 3 villages *viz.* Khatla, Bhatipara and Baniavita.

Initially, the benchmark survey was conducted in all the above mentioned 6 villages and the informations were generated on socio-economic and cultural behaviour of the people. The farmers of the villages were mostly marginal having land holding size ranging between 0.30 – 1.10 ha. Rice mono-cropping was the predominant cropping sequence in case of all the villages, where only summer rice was cultivated. The predominant farming system in Chamaria block was Crops+Livestock+Fishery, whereas Crops+Livestock was only the predominant farming system in Boko block.

A total of 24 farmers were selected, at random @ 4 farmers from each village and rice-rice cropping sequence was introduced to all the 24 farmers. Luit (100 days duration) and Joymoti (165 days duration) variety were selected for post-flood and pre-flood crop, respectively. The pre-flood crop was sown in the nursery bed on 16th November, 2013, transplanted 45 days old seedlings and the crop was harvested on 29th April, 2014. On the other hand, the sowing of the post-flood crop in the nursery bed was done on 12th August, 2014, transplanted after 30 days and harvesting was done on 20th November, 2014.

Soil samples were collected before commencement of the cropping sequence and were analysed for initial soil test value which are presented in the (Table 1). NPK uptake by crops was also analysed following the internationally standard procedures. To study the on-farm response in case of the rice-rice cropping sequence to the applied nutrients; different combination of fertilizers were applied. There were 7 treatment combinations *viz.* T_1: Control (No fertilizers), T_2: 100% recommended dose of N, T_3: 100% recommended dose of N and P, T_4: 100% recommended dose of N and K, T_5: 100% recommended dose of N, P and K, T_6: T_5 + 5 Kg/ha $ZnSO_4$ and T_7: Farmers Practice. All these treatments were applied to the rice-rice sequence under field conditions of the selected 24 farmers of Chamaria and Boko block of Kamrup (Rural) district of Assam. The recommended dose of fertilizers was 40, 20 and 20Kg per hectare N, P_2O_5 and K_2O respectively for both the post flood and pre-flood rice crop. The farmer's practice method included application 20, 10 and 10Kg per hectare N, P_2O_5 and K_2O respectively for the post flood rice crop only. N, P and K nutrients applied through chemical fertilizers were in the form of Urea, Single Super Phosphate (SSP) and Muriate of Potash (MOP). All other agronomic management practices of the sequence were followed as per recommended practices prescribed for the locality.

RESULTS AND DISCUSSION

Post harvest soil properties and nutrient uptake of rice-rice sequence: Post harvest soil properties *viz.* pH, organic carbon, electrical conductivity and NPK status of soil as affected by nutrient management practices in case of rice-rice sequence in the villages under Chamaria and Boko Block of Kamrup (Rural) district of Assam (India) are presented in (Table 2 and 3). Soil pH was acidic and no remarkable change was observed even with the application at various combinations of N, P and K fertilizers. However, there were considerable increase in organic carbon (OC) and electrical conductivity (EC) status of soil over initial in case of T_5 (*i.e.* 100% RDF) and T_6 (*i.e.* 100% RDF + $ZnSO_4$ @ 5 Kg/ha) treatment after the rice-rice sequence. The post harvest N, P and K status of soil were found to be highest when recommended dose of fertilizers were applied along with 5 Kg $ZnSO_4$ per hectare. Higher availability of N, P and K status of soil may be attributed to balanced application of nutrients supplying both macro and micro nutrients sources of fertilizers. Lowest availability of nutrients was recorded in case of control treatment and also in case of farmer's practice methods (application of N, P_2O_5 and K_2O @ 20, 10 and 10 Kg/ha, respectively for the post-flood rice only).

Table 2: Post harvest soil properties as affected by nutrient management practices with rice-rice sequence in the villages of Chamaria Block of Kamrup (Rural) district of Assam

Treatments	Hekra village						Mondira village						Jogipara village					
	pH	OC (%)	EC (dS/m)	Available nutrients (Kg/ha) N	P_2O_5	K_2O	pH	OC(%)	EC (dS/m)	Available nutrients (Kg/ha) N	P_2O_5	K_2O	pH	OC (%)	EC (dS/m)	Available nutrients (Kg/ha) N	P_2O_5	K_2O
T_1	5.20	0.63	0.20	326.18	17.40	266.28	4.70	0.98	0.16	299.60	17.36	261.64	4.75	0.93	0.15	305.14	19.86	254.51
T_2	5.59	0.75	0.33	308.57	17.40	266.83	5.05	1.45	0.30	303.75	17.67	262.53	5.15	1.38	0.31	314.24	20.10	255.05
T_3	5.60	0.72	0.32	334.58	21.45	211.07	5.05	1.23	0.29	305.82	22.06	263.15	5.23	1.71	0.25	313.82	26.38	255.63
T_4	5.30	0.68	0.33	335.47	17.30	272.61	4.75	1.08	0.30	305.38	17.54	251.56	4.88	1.04	0.26	315.59	20.05	259.45
T_5	5.40	0.71	0.35	334.97	21.48	274.15	4.88	1.16	0.30	306.36	22.91	244.11	5.18	1.23	0.26	316.11	24.46	259.54
T_6	5.31	0.68	0.36	335.27	22.59	249.18	4.93	1.11	0.34	307.32	23.78	250.68	5.25	1.22	0.33	317.64	25.67	260.28
T_7	5.50	0.64	0.27	327.40	17.68	267.99	4.63	0.98	0.20	300.98	18.37	262.69	4.85	0.92	0.19	306.15	21.31	255.52
Initial	5.30	0.58	0.24	331.19	19.21	270.92	4.80	1.08	0.20	301.01	19.75	248.65	4.90	1.04	0.19	310.45	23.01	256.52

Here, T_1: Control (No fertilizers), T_2: 100% recommended dose of N, T_3: 100% recommended dose of N and P, T_4: 100% recommended dose of N and K, T_5: 100% r ecommended dose of N, P and K, T_6: T_5 + 5 Kg/ha $ZnSO_4$ and T_7: Farmers Practice.

Table 3: Post harvest soil properties as affected by nutrient management practices with rice-rice sequence in the villages of Boko Block of Kamrup (Rural) district of Assam

Treatments	Khatla village						Bhatipara village						Baniavita village					
	pH	OC (%)	EC	Available nutrients (Kg/ha) N	P_2O_5	K_2O	pH	OC(%)	EC	Available nutrients (Kg/ha) N	P_2O_5	K_2O	pH	OC (%)	EC	Available nutrients(Kg/ha) N	P_2O_5	K_2O
T_1	4.37	1.18	0.16	344.50	18.98	271.73	4.95	0.84	0.18	324.85	19.88	271.08	7.75	1.01	0.15	293.82	18.21	227.99
T_2	5.13	1.30	0.25	330.12	19.27	273.53	5.40	1.13	0.30	328.00	20.16	270.44	5.15	1.45	0.30	301.73	18.70	228.37
T_3	5.38	1.50	0.27	330.45	23.97	273.09	5.45	1.07	0.25	328.72	25.26	271.21	5.13	1.32	0.25	301.46	24.12	228.92
T_4	4.83	1.13	0.27	332.07	19.01	278.98	5.10	0.92	0.26	334.91	19.97	277.41	4.85	1.15	0.26	304.38	18.26	233.89
T_5	4.95	1.20	0.28	332.35	24.29	281.51	5.20	0.97	0.26	335.39	25.49	277.44	4.98	1.23	0.26	304.94	23.13	232.43
T_6	4.98	1.29	0.34	334.92	25.92	279.84	5.23	1.06	0.32	335.10	26.02	277.32	4.98	1.18	0.31	307.50	24.66	233.75
T_7	4.85	1.09	0.18	322.26	19.51	272.16	5.00	0.89	0.21	326.46	20.47	270.44	4.73	1.06	0.18	294.64	20.92	229.04
Initial	4.80	1.13	0.19	326.76	21.45	276.15	5.10	0.92	0.22	330.20	22.91	274.86	4.90	1.15	0.19	298.46	21.28	230.80

Here, T_1: Control (No fertilizers), T_2: 100% recommended dose of N, T_3: 100% recommended dose of N and P, T_4: 100% recommended dose of N and K, T_5: 100% recommended dose of N, P and K, T_6: T_5 + 5 Kg/ha $ZnSO_4$ and T_7: Farmers Practice.

The NPK uptakes by the rice-rice sequence were significantly affected by the on-farm nutrient management practices (Table 4). The uptake of N, P and K by rice-rice cropping system were ranged from 42.41 to 108.03, 20.94 to 48.56 and 29.91 to 72.50 Kg/ha, respectively. Uptake of nutrients by the sequence were highest when $ZnSO_4$ @ 5 kg/ ha was applied along with the recommended dose of fertilizers. More uptake of nutrients may be attributed to more yield of crops from this treatment. On the other hand, lowest NPK uptake were recorded in case of farmer's practice method (*i.e.* application 20, 10 and 10 Kg N, P_2O_5 and K_2O/ ha, respectively for the post-flood rice crop only) and in control treatment. Similar kind of results has been reported by Ravichandran *et al.* (2006), Jana *et al.* (2009) and Trivedi *et al.* (2015).

Yield of the rice-rice sequence: Data on grain and straw yields of winter and autumn rice as affected by nutrient management practices in 6 villages under Chamaria and Boko Block of Kamrup (Rural) district of Assam (India) are presented in Table 5 and 6, respectively. The grain yield of post-flood rice crop were ranged between 15.48 and 38.05 q/ha, and straw yields were between 23.53 and 45.77 q/ha. On the other hand, the yield of grain and straw of pre-flood rice crop were varied from 19.15 to 51.45 and 33.36 to 57.36 q/ha, respectively. The highest yield of crops were recorded by means of application of recommended dose of fertilizers along with 5 Kg $ZnSO_4$, followed by application of recommended dose of NPK fertilizer treatment. This yield enhancement might be linked to the role of Zn for the activation of enzymes related to the biosynthesis and translocation of carbohydrates during grain filling as well as the role of Zn for improving pollination and fertilization that eventually resulted in an increased grain filling. Similarly, Ebaid (2005) and Shivey *et al.,* (2008) reported that application of $ZnSO_4$ increased the grain and straw yield of rice crop.

The treatment lacking either in P or K showed less crop yield as compared to that of the combine application of N, P and K fertilizers. In consequence, lowest yield was observed in case of control (without fertilizers) treatment. Several other scientists (Zia *et al*., 2007; Singh and Tripathi, 2008; Reddy *et al*., 2010) reported the results in conformity with the results of present study. Regmi *et al.,* (2003) also found consistently higher yield of rice in the NPK treatments than in treatments where one or more nutrients were lacking in case of a 20-years experiment. Further, 100% NPK + 5 Kg/ha Zn (along with S @ 40 kg/ha) in case of rice was reported to be best for the farmers so far as grain yield, straw yield and nutrient uptake values are concerned (Trivedi *et al.,* 2015).

Economics of the system: Economics of the on-farm crop response studies on plant nutrient management in rice-rice sequence under rainfed situation of Kamrup (Rural) district

Table 4: NPK uptake (Kg/ha) of the rice-rice sequence as affected by On-farm plant nutrient management under rainfed situation

Treatments	Chamaria Block of Kamrup (Rural)									Boko Block of Kamrup (Rural)								
	Hekra village			Mondira village			Jogipara village			Khatla village			Bhatipara village			Baniavita village		
	N	P	K	N	P	K	N	P	K	N	P	K	N	P	K	N	P	K
T_1	46.32	23.05	34.22	51.51	26.45	38.48	49.62	23.80	38.33	44.51	25.12	37.31	45.20	20.94	32.46	44.10	22.94	33.75
T_2	69.60	30.47	41.97	72.96	30.03	41.65	71.26	32.04	41.50	73.08	29.77	41.59	66.15	29.41	39.55	69.65	28.42	39.07
T_3	78.10	35.96	45.79	78.61	37.99	45.80	76.60	35.07	42.73	79.15	34.42	45.43	69.95	36.00	46.14	73.37	36.01	45.51
T_4	85.53	37.54	61.24	85.15	38.02	59.97	81.12	35.75	54.50	83.33	35.80	56.67	75.31	32.24	50.24	74.77	32.57	48.98
T_5	97.22	43.45	67.38	102.81	45.60	66.62	98.52	43.42	68.76	92.69	40.80	57.87	88.29	40.88	53.12	101.46	46.04	64.41
T_6	104.55	46.17	72.50	108.03	48.56	66.45	105.68	44.44	63.31	99.11	44.81	64.89	93.79	40.92	63.00	105.69	45.14	68.038
T_7	46.87	24.08	33.36	50.087	24.00	37.14	46.62	23.90	32.18	42.41	21.93	31.76	43.94	21.53	29.91	44.44	22.27	31.40

Here, T_1: Control (No fertilizers), T_2: 100% recommended dose of N, T_3: 100% recommended dose of N and P, T_4: 100% recommended dose of N and K, T_5: 100% recommended dose of N, P and K, T_6: T_5 + 5 Kg/ha $ZnSO_4$ and T_7: Farmers Practice.

Table 5: Yield of Post-flood rice crop (q/ha) as affected by nutrient management practices with rice-rice sequence in Chamaria and Boko Block of Kamrup (Rural) district of Assam

Treatments	Chamaria Block						Boko Block					
	Hekra village		Mondira village		Jogipara village		Khatla village		Bhatipara village		Baniavita village	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
T_1	17.19	23.85	21.13	28.55	18.60	28.36	21.88	30.68	21.60	29.61	16.75	27.57
T_2	21.42	29.97	24.11	32.62	21.83	31.94	24.75	33.77	24.17	33.99	19.40	30.43
T_3	24.72	33.59	27.55	36.26	23.99	33.58	28.90	38.21	27.78	38.09	22.76	32.63
T_4	29.27	39.06	29.50	39.80	28.09	37.47	30.15	39.02	29.74	39.58	24.13	34.96
T_5	31.77	40.61	34.39	43.56	32.80	51.39	36.91	43.11	33.01	41.50	33.86	42.53
T_6	33.23	42.76	35.65	45.29	34.80	43.89	38.05	45.77	34.61	44.46	35.35	44.36
T_7	15.88	23.53	20.00	29.24	16.75	27.65	19.13	29.18	19.12	29.73	15.48	26.48

Here, T_1: Control (No fertilizers), T_2: 100% recommended dose of N, T_3: 100% recommended dose of N and P, T_4: 100% recommended dose of N and K, T_5: 100% recommended dose of N, P and K, T_6: T_5 + 5 Kg/ha $ZnSO_4$ and T_7: Farmers Practice.

Table 6: Yield of Pre-flood rice crop (q/ha) as affected by nutrient management practices with rice-rice sequence in Chamaria and Boko Block of Kamrup (Rural) district of Assam

Treatments	Chamaria Block						Boko Block					
	Hekra village		Mondira village		Jogipara village		Khatla village		Bhatipara village		Baniavita village	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
T_1	28.95	41.74	30.83	43.35	29.35	41.88	25.90	38.03	21.88	33.82	27.50	38.13
T_2	35.48	44.83	35.58	45.13	37.73	43.81	31.55	43.66	29.28	41.37	33.75	43.18
T_3	39.38	46.10	38.93	45.08	37.73	45.26	34.03	42.63	31.90	41.43	35.15	44.i23
T_4	42.08	49.61	42.88	47.47	41.40	47.50	37.14	45.79	32.78	43.45	36.23	44.35
T_5	44.40	54.17	47.68	52.45	45.53	52.13	38.82	47.28	36.99	46.48	44.73	52.35
T_6	49.44	56.65	51.45	57.36	49.04	56.75	39.81	48.96	41.54	48.36	46.10	54.23
T_7	28.03	39.37	27.60	39.57	26.55	37.02	22.00	33.55	19.15	33.36	24.73	36.60

Here, T_1: Control (No fertilizers), T_2: 100% recommended dose of N, T_3: 100% recommended dose of N and P, T_4: 100% recommended dose of N and K, T_5: 100% recommended dose of N, P and K, T_6: T_5 + 5 Kg/ha $ZnSO_4$ and T_7: Farmers Practice.

of Assam are presented in Table 7. The costs of cultivation incurred in the different villages under both the blocks *viz.* Chamaria and Boko Block were same; however it varied from Rs. 41,600.00 to Rs. 50,918.00 based on the treatment's differences. Among the treatments, application of 100% recommended NPK dose plus $ZnSO_4$ (@5 Kg/ha offered the highest net return and Benefit: Cost ratio (B:C ratio) from the rice-rice sequence under the rainfed situation of Lower Brahmaputra Valley Zone (LBVZ) of Assam. Highest net return of Rs. 46,476.00 with the highest B:C ratio (1.91) was obtained from the Mondira village of Chamaria block followed by a net return of Rs. 40392.00 and B:C ratio of 1.79 from the Baniavita village of Boko block. It was obtained because of the use of balanced fertilizers resulting increase in crop yield from this treatment.

The Figure 1 depicts the average B:C ratio of the rice-rice sequence as affected by on-farm nutrient management practices under rainfed situation of LBVZ of Assam. The average B:C ratio was highest when 5 Kg/ha $ZnSO_4$ was added with recommended NPK fertilizer dose, followed by the treatment receiving recommended NPK fertilizer doses only.

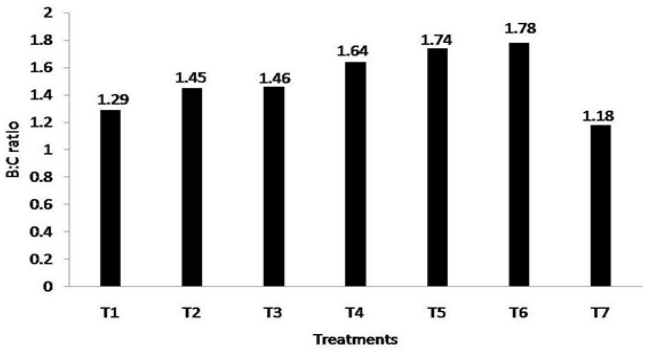

Fig-1: Average Benefit: Cost ratio (B:C ratio) of the on-farm crop response studies in plant nutrient management with rice-rice sequence under rainfed situation

Here, T_1: Control (No fertilizers), T_2: 100% recommended dose of N, T_3: 100% recommended dose of N and P, T_4: 100% recommended dose of N and K, T_5: 100% recommended dose of N, P and K, T_6: T_5 + 5 Kg/ha $ZnSO_4$ and T_7: Farmers Practice.

CONCLUSION

From the on-farm trial conducted under the rainfed situation of Assam, it can be concluded that application of $ZnSO_4$ @ 5 Kg/ha along with the recommended dose of fertilizers not only enhances the fertility status of soil but also increases in crop yields and income per unit area in Inceptisols of Lower Brahmaputra Valley Zone. Hence, in case of rice-rice cropping sequence recommended dose of NPK fertilizers along with 5Kg $ZnSo_4$ may be recommended for Lower Brahmaputra Valley Zone of Assam.

Table 7: Economics of the on-farm crop response studies in plant nutrient management with rice-rice sequence under rainfed situation

Treatments	Cost of cultivation (in Rs.) of rice-rice sequence	Chamaria Block of Kamrup (Rural) district						Boko Block of Kamrup (Rural) district					
		Hekra village		Mondira village		Jogipara village		Khatla village		Bhatipara village		Baniavita village	
		Net return (in Rs.)	B:C ratio	Net return (in Rs.)	B:C ratio	Net return (in Rs.)	B:C ratio	Net return (in Rs.)	B:C ratio	Net return (in Rs.)	B:C ratio	Net return (in Rs.)	B:C ratio
T_1	41600.00	11245.00	1.27	17542.00	1.42	13374.00	1.32	13046.00	1.31	8214.00	1.20	9220.00	1.22
T_2	44164.00	20205.00	1.46	23294.00	1.53	21328.00	1.49	20730.00	1.47	15811.00	1.38	16343.00	1.37
T_3	47918.00	24142.00	1.50	26688.00	1.56	21680.00	1.45	22938.00	1.48	19711.00	1.41	17680.00	1.37
T_4	46168.00	34046.00	1.74	34932.00	1.76	31821.00	1.69	29602.00	1.64	24648.00	1.54	22113.00	1.48
T_5	49918.00	35730.00	1.72	41758.00	1.84	37705.00	1.75	34856.00	1.70	30480.00	1.61	39794.00	1.80
T_6	50918.00	41443.00	1.81	46476.00	1.91	42984.00	1.85	36462.00	1.72	38689.00	1.61	40392.00	1.79
T_7	41600.00	8455.00	1.21	12808.00	1.31	8184.00	1.20	5797.00	1.14	3827.00	1.08	4909.00	1.12

Here, T_1: Control (No fertilizers), T_2: 100% recommended dose of N, T_3: 100% recommended dose of N and P, T_4: 100% recommended dose of N and K, T_5: 100% recommended dose of N, P and K, T_6: T_5 + 5 Kg/ha $ZnSO_4$ and T_7: Farmers Practice.

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