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## Nutrients availability of soil and yield of rice (*Oryza Sativa* L.) as influence by various customized fertilizers

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**Abstract**

A field experiment was conducted to study the nutrients availability of soil and yield of rice (*Oryza Sativa* L.) as influence by various customized fertilizers at Agronomy Research Farm of ND University of Agriculture and Technology, Faizabad during *Kharif*, 2014 and 2015. The application of Soil Test Based Recommendation (N-140:P<sub>2</sub>O<sub>5</sub>-60: K<sub>2</sub>O-30: S-30: Zn-5: B-2 kg ha<sup>-1</sup>) was found maximum plant height (cm), number of tillers m<sup>-2</sup> at different stages, number of grains per panicle, test weight of rice crop which was at par with (Indo Gulf) and (Tata Chemical Limited) and significantly superior over control, RDF and Farmer's practices during both the year. Pooled data of two year grain and straw yield of rice and nutrients availability of nitrogen, phosphorus, potassium, sulphur, zinc and boron in soil were recorded highest in T<sub>3</sub> (Soil test based recommendation) treatments which was significantly superior over the control, RDF and Farmers' practices and statically at par with Vardan (Indo gulf) and Paras (TCL). The highest net return (Rs.32204 and Rs.34968 ha<sup>-1</sup>) and B:C (0.74 and 0.84) during 2014 and 2015, respectively were also obtained due to application of soil test based recommendation which was followed by application of Indo Gulf- Customized Fertilizers- Vardan and TCL- Customized fertilizers- Paras.

**Keywords:** Growth, yield, nutrients availability, economics, TCL, indo-gulf

**Introduction**

Rice (*Oryza sativa* L.) is one of the most important cereal crops of *kharif* season. It is one of the richest starch foods and consumed by about half of the world's population. It is the principle food of the world's human population inhabiting in the humid tropics and subtropics. Rice is cultivated world-wide over an area of about 156.68 million ha with an annual production of about 650.19 million tonnes with the productivity 4.15 tonnes per hectare. In India, rice is cultivated over an area of about 39.47 million hectares with an annual production of about 87.10 million tonnes and the productivity of 2.20 tonnes. Uttar Pradesh is an important rice growing state in the country. The area and production of rice in this state is about 13.84 million hectare and 14.00 million tonnes respectively with an average production of 2.35 tonnes (Anonymous, 2012) [2]. Customized fertilizers are multi-nutrient carriers facilitating the application of the complete range of plant nutrients in right proportion to suit the specific requirements of a crop during its stages of growth. Soil fertility status, climate, and cropping pattern in a region pave the way for the development of customized fertilizer formulations. Customized fertilizers are unique and ready to use granulated fertilizers, formulated on sound scientific plant nutrition principles integrated with soil information, extensive laboratory studies and evaluated through field research. Customized fertilizers development process is complex but, the end very promising. Such fertilizers also include water soluble specialty fertilizer as customized combination products. The Nutrient requirement of the crop in a particular area is mixed physically and steam granulated by technology known as fusion blending Yadav, 2012 [19]. The farmers get all the required nutrients in terms of NPK with secondary and micro-nutrients in balanced proportion. A large number of customized fertilizer grades proposed by a number of companies have been included in fertilizer control order which is multi-nutrient carriers designed to contain primary, secondary and micro nutrients. These products are manufactured through a systematic process of granulation providing uniform quality. The products have been validated by a scientific crop model, by a fertilizer manufacturing company and can meet crop nutritional needs which is

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specific to site, soil and stage of crop. Depending on the soil test results, climate, water requirement and crop chosen, a particular type of grade of fertilizer (customized fertilizers) is prescribed to get the best yield and maintain soil health.

### Materials and Methods

A fixed plot field experiment was carried out at Agronomy Research Farm, Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad (Uttar Pradesh) India during *kharif* season 2014 and 2015. This region comes under subtropical zone. Sub tropical zone which is characterized by hot and dry summer with cold winters. Rain is more often confined to the period from July to September with occasional winter and summer rain. The average annual rainfall of the area is around 1200 mm. Nearly 85 per cent of total rainfall is received from South-West monsoon during the month of July to September. However, occasional mild rains occur during winter season. The total rainfall of 1072.8 mm and 750.5 mm were received during *kharif*, 2014 and 2015 respectively. Maximum temperature is 34.4 and 34.2°C and minimum temperature is 26.7 and 27.7 °C in 2014 and 2015 respectively, during crop season. The experimental field was well level having good drainage facilities.

The soil of the experimental field is alluvial, developed from the alluvium deposited by rivers. The partially reclaimed sodic soil belongs to the order Inceptisol with silt loam

texture. The data on physico-chemical properties of the experimental soil are with slight alkaline (pH 8.1), EC 0.41 dSm<sup>-1</sup>, being low in organic carbon (3.70 g kg<sup>-1</sup>), available nitrogen (160.76 kg), medium in available phosphorus (15.40 kg), medium in potassium (280.70 kg), sulphur (8.2 ppm), Zn (0.50 ppm) and B (0.39 ppm). Field experiments were laid out in randomized block design (RBD) replicated four. The experiments consisted of six treatments (Table 1). The planting was done at a spacing of 20 cm x 10 cm. Cost of production for all treatments was worked out on the basis of the prevailing input and market price of the produce. The variety 'NDR-359' for rice crop was used as test crop. During the years of experimentation, the crop was transplanted on 29th July 2014 and 25th July in 2015 and harvested on Oct, 29th in 2014 and 28 Oct, 2015. Post-harvest soil samples were drawn 15 cm soil depth and analyzed for available N by alkaline permanganate method Subbiah and Asija, (1956) [18], available phosphorus (P) by 0.5 M NaHCO<sub>3</sub>. Extractable Olsen's Colorimetric method Olsen's, (1954) [11], available potassium (K) by neutral normal ammonium acetate method (Jackson, 1973) [8], S by Turbidimetric method Chesnin and Yien, (1950) [56] and Micronutrient analysis was carried out by AAS. The data was analyzed by the method of analysis of variance as described by Snedecor and Cochran, (1967) [16]. The level of significance used in "F" test was given at 5%.

**Table 1:** Treatment details

T <sub>1</sub> : Control
T <sub>2</sub> : 100% RDF (N-150: P <sub>2</sub> O <sub>5</sub> -60: K <sub>2</sub> O -60:ZnSO <sub>4</sub> -25 kg/ha)
T <sub>3</sub> : STR (N-140: P <sub>2</sub> O <sub>5</sub> -60: K <sub>2</sub> O-30:S-30:Zn-5:B-2 kg/ha)
T <sub>4</sub> : Indo Gulf- Customized Fertilizers- Vardan (N-30, P <sub>2</sub> O <sub>5</sub> -65, K <sub>2</sub> O-45, S-12.5 & Zn-1.25 kg/ha)+N-115 kg ha <sup>-1</sup> at Tillering stage and panicle initiation stage
T <sub>5</sub> : TCL- Customized fertilizers- Paras (N-25, P <sub>2</sub> O <sub>5</sub> -65, K <sub>2</sub> O-42.5, Zn- 2.5 & B-0.75 kg/ha) + N-115 kg ha <sup>-1</sup> at Tillering stage and panicle initiation stage
T <sub>6</sub> : Farmer's practice (N-100, P <sub>2</sub> O <sub>5</sub> -40, K-0, ZnSO <sub>4</sub> -10 kg ha <sup>-1</sup> )

### Results and Discussion

#### Plant height at different stages (cm)

Plant height at different growth stages at 30, 60 and 90 DAT and at harvest have been presented in (Table 1). The maximum plant height 35.70, 58.40, 82.60 and 90.40 cm during 2014 and 36.40, 59.50, 84.28 and 92.02 cm in 2015 at 30, 60, 90 and at harvest respectively, were recorded with the application of STR, which was significantly superior over the Control, RDF and Farmer's practices and statistically at par with Indo Gulf- Customized Fertilizers- Vardan and TCL- Customized fertilizers- Paras. Data showed that splitting top dressed N dose in two instalments, first at crown root initiation stage and second at first node stage, resulted in greater. Through statistically insignificant, plant height than that grained in top dressing N in one dose at CRI stge. The higher plant height with split top dressed N has been reported extensively Bhardwaj *et al.*, (2010) [5], Oscarson *et al.* (1995) [12]. It might have resulted from increasing production of photosynthesis by prolonged availability of fertilizer N Bhardwaj *et al.*, (2010) [5].

#### Number of tillers m<sup>-2</sup> at different growth stages

Number of tillers m<sup>-2</sup> at 30, 60, 90 DAT and at harvest have been presented in (Table 3). The maximum Number of tillers m<sup>-2</sup> 168.0, 378.4, 473.0 and 471.9 during 2014 and 174.7, 393.5, 491.9 and 589.6 in 2015 at 30, 60, 90 DAT and at harvest stages respectively, were recorded with the application of STR, which was significantly superior over the

control, RDF and Farmer's practices and statistically at par with Indo Gulf- Customized Fertilizers- Vardan and TCL- Customized fertilizers- Paras.

#### Number of grains per panicle

The maximum number of grains per panicle (131.8 and 138.4) recorded with the application of STR was significantly superior over the control and Farmer's practices and statistically at par with RDF, Indo Gulf- Customized Fertilizers- Vardan and TCL- Customized fertilizers- Paras during both the years of investigation. The minimum number of grains per panicle (60.0 and 63.0) was recorded under control during 2014 and 2015, respectively. Application of 100% RDF through customized fertilizer registered an increase in rice yield of 22.2% over the application of straight fertilizers. Addition of Zn through customized fertilizer could have attributed to increase in number of number of grains per panicle Kaleeswari, (2013) [9].

#### Test weight (g)

The data obtained on test weight as influenced by various treatments have been presented in Table 4. The maximum test weight (23.80 and 23.83 g) recorded with the application of T<sub>3</sub>- STR was statistically at par with all other treatments during both the years of investigation. However, the minimum test weight (22.40 and 22.43 g) was recorded under control during both the years of investigation, respectively.

**Grain and straw yield (q ha<sup>-1</sup>)**

The maximum pooled grain yield (48.81q ha<sup>-1</sup>) recorded with the application of T3 - STR was significantly superior over the T1- Control (18.32 q ha<sup>-1</sup>), T2-RDF (43.42 q ha<sup>-1</sup>) and T6 -Farmer's practices (28.36 q ha<sup>-1</sup>) and statistically at par with T4- Indo Gulf- Customized Fertilizers- Vardan (48.33 q ha<sup>-1</sup>) and T5- TCL- Customized fertilizers- Paras (47.50 q ha<sup>-1</sup>). The minimum pooled grain yield (18.32 q ha<sup>-1</sup>) was recorded with control. Maximum pooled straw yield (75.31 q ha<sup>-1</sup>) recorded with the application of T3 - STR was significantly superior over the T1- Control (29.74 q ha<sup>-1</sup>) and T6 -Farmer's practices (44.57 q ha<sup>-1</sup>) and statistically at par with T2-RDF (69.04 q ha<sup>-1</sup>), T4- Indo Gulf- Customized Fertilizers- Vardan (73.98 q ha<sup>-1</sup>) and T5- TCL- Customized fertilizers- Paras (72.58 q ha<sup>-1</sup>). The minimum pooled straw yield (29.74 q ha<sup>-1</sup>) was recorded with control. The increase in grain, straw yield and harvest index were affected with the supplement of, supplied the nutrient in combination through Basel and top dressing at tillering and panicle initiation of the fertilizers. Thereby improving the efficiency in utilization of nutrient as well as applied nutrients which ultimately improved the yield attributing characters and yield of crop. The addition of Zn through customized fertilizer could have attributed to increase in grain yield of rice, Kaleeswari, 2013 [9]. These results are also corroborating with the findings of Rashid *et al.* (2004) [14], Singh *et al.* (2011) [15] and Rahman *et al.* (2008) [13].

**Available N, P and K (kg ha<sup>-1</sup>)**

The maximum available N (176.00 and 176.12 kg ha<sup>-1</sup>), P (18.90 and 19.35 kg ha<sup>-1</sup>), K (254.60 and 256.10 kg ha<sup>-1</sup>), S (14.70 and 15.06 ppm) Zn (0.63 and 0.67 pm) and B (0.54 and 0.56 ppm) in soil after harvest of soil were recorded with the application of Soil Test Based on Recommendation (N-140:P<sub>2</sub>O<sub>5</sub>-60:K<sub>2</sub>O-30:S-30:Zn-5:B-2 kg ha<sup>-1</sup>) during 2014 and 2015, respectively. Which was statistically at par with Indo Gulf- Customized Fertilizers- Vardan and TCL- Customized fertilizers- Paras and significantly superior over rest of the treatments during both the years. This might be due to favorable soil condition by the application of customized fertilizer which increased activity of microbes and thereby increase in available nitrogen and phosphorus status of soil.

Similar findings were observed by Bajpai *et al.*, (2006) [3] and Srinivas *et al.*, (2010) [17].

**Available S, Zn and B (ppm)**

The maximum available S (14.70 and 15.06 ppm) Zn (0.63 and 0.67 pm) and B (0.54 and 0.56 ppm) in soil after harvest of soil were recorded with the application of soil test based on recommendation (N-140:P<sub>2</sub>O<sub>5</sub>-60:K<sub>2</sub>O-30:S-30:Zn-5:B-2 kg ha<sup>-1</sup>) during 2014 and 2015, respectively. Which was statistically at par with Indo Gulf- Customized Fertilizers- Vardan and TCL- Customized fertilizers- Paras and significantly superior over rest of the treatments during both the years. The availability of S depends on the solubilisation and mineralization process. When the availability of Zn and B increases the efficiency of primary and secondary nutrients (N, P, K, and S) were also enhanced. Available S and Zn status of the soil reduced in the soil from their initial status in S and Zn free treatments Barthwal *et al.*, (2013) [4]. Similar result was also reported by Ahmed *et al.*, (2014). Micronutrients, particularly Zn, and B play key roles in growth and metabolism of rice plant, hence are essential for enhancing yield of rice. Micronutrient deficiencies are now frequently observed in intensively grown rice based areas of eastern India. The most commonly observed micronutrient disorder in rice based cropping system is zinc deficiency. Therefore, application of zinc is felt necessary throughout the growth cycle of rice crop. Nayak, *et al.* 2018 [10].

**Economics of various treatments**

Economic efficiency of various treatments taken in this study was worked out on the basis of input-output relationship with respect to net return (Rs ha<sup>-1</sup>) and benefit/cost ratio (B:C). The minimum support price of rice crops during the field experimentation was taken into account for this purpose. Maximum net return Rs. 32204 ha<sup>-1</sup> and Rs. 34968 ha<sup>-1</sup> and B:C 0.74 and 0.84 were obtained under the treatments T<sub>3</sub> (STR) followed by Indo-Gulf Customized fertilizers and TCL- Customized fertilizers. While, negative net return and B:C were found in control where no source of fertilizers were used in both crops. Similar findings were found in results of Dwivedi *et al.*, (2014) [7].

**Table 2:** Effect of customized fertilizer on plant height (cm) at different stages of rice crop

Treatments	30 DAT		60 DAT		90 DAT		At harvest	
	2014	2015	2014	2015	2014	2015	2014	2015
T <sub>1</sub> -Control (No fertilizer application)	32.40	33.00	42.50	43.30	55.70	56.80	60.20	61.40
T <sub>2</sub> -Recommended dose of fertilizer (RDF) (N-150: P <sub>2</sub> O <sub>5</sub> -60: K <sub>2</sub> O -60:ZnSO <sub>4</sub> -25 kg/ha)	34.60	35.30	52.20	53.20	75.50	77.0	82.20	83.80
T <sub>3</sub> -Soil Test Based on Recommendation (STR) (N-140:P <sub>2</sub> O <sub>5</sub> -60:K <sub>2</sub> O-30:S-30:Zn-5:B-2 kg ha <sup>-1</sup> )	35.70	36.40	58.40	59.50	82.60	84.25	90.40	92.20
T <sub>4</sub> - Indo Gulf Customized fertilizer (Vardan) @ 250 kg ha <sup>-1</sup> + N-115 kg	35.20	35.90	57.20	58.30	80.30	81.90	88.60	90.40
T <sub>5</sub> - Tata Chemical Limited customized fertilizer (Paras) @ 250 kg ha <sup>-1</sup> + N-115 kg	34.80	35.50	56.30	57.40	79.70	81.30	87.20	88.90
T <sub>6</sub> Farmers' practices (N-100, P <sub>2</sub> O <sub>5</sub> -40, K-0, ZnSO <sub>4</sub> -:10 kg/ha)	33.30	33.90	48.10	49.10	63.20	64.50	65.60	66.90
SEm±	0.87	0.89	1.37	1.40	2.15	2.20	2.34	2.72
C.D. at 5%	2.64	2.69	4.14	4.22	6.50	6.63	7.06	8.19

**Table 3:** Effect of customized fertilizer on of Number of tillers m<sup>-2</sup> at different growth stages of rice crop.

Treatments	30 DAT		60 DAT		90 DAT		At harvest	
	2014	2015	2014	2015	2014	2015	2014	2015
T <sub>1</sub> -Control (No fertilizer application)	110.0	114.2	158.4	164.7	198.0	205.9	193.4	201.2
T <sub>2</sub> -Recommended dose of fertilizer (RDF) (N-150: P <sub>2</sub> O <sub>5</sub> -60: K <sub>2</sub> O -60:ZnSO <sub>4</sub> -25 kg/ha)	150.0	156.0	334.4	347.7	418.0	434.7	415.2	432.6
T <sub>3</sub> -Soil Test Based on Recommendation (STR) (N-140:P <sub>2</sub> O <sub>5</sub> -60:K <sub>2</sub> O-30:S-30:Zn-5:B-2 kg ha <sup>-1</sup> )	168.0	174.7	378.4	393.5	473.0	491.9	471.9	589.6
T <sub>4</sub> - Indo Gulf Customized fertilizer (Vardan) @ 250 kg ha + N-115 kg	162.0	168.5	371.3	386.2	464.2	482.7	462.1	480.9
T <sub>5</sub> - Tata Chemical Limited customized fertilizer (Paras) 250 kg/ha+ N-115 kg	158.0	164.3	365.2	379.8	456.5	474.8	455.3	472.2
T <sub>6</sub> Farmers' practices (N-100, P <sub>2</sub> O <sub>5</sub> -40, K-0, ZnSO <sub>4</sub> -:10 kg/ha)	125.0	130.0	228.8	237.9	286.0	297.5	283.1	293.4
SEm±	5.67	5.67	11.82	12.29	14.64	15.20	15.33	15.99
C.D. at 5%	17.09	17.10	35.64	37.06	44.12	45.88	46.22	48.06

**Table 4:** Effect of customized fertilizer on Number of grains per panicle, Test weight grain and straw yield (pooled 2 year) in rice crop

Treatments	No. of grains per panicle		Test weight (g)		Yield (q ha <sup>-1</sup> )		Harvest Index (%)	
	2014	2015	2014	2015	Grain	straw	2014	2015
T <sub>1</sub> –Control (No fertilizer application)	60.0	63.0	22.40	22.43	18.32	29.74	37.72	38.45
T <sub>2</sub> –Recommended dose of fertilizer (RDF) (N-150: P <sub>2</sub> O <sub>5</sub> -60: K <sub>2</sub> O - 60:ZnSO <sub>4</sub> -25 kg/ha)	124.3	130.5	23.10	23.14	43.42	69.04	39.98	37.48
T <sub>3</sub> –Soil Test Based on Recommendation (STR) (N-140:P <sub>2</sub> O <sub>5</sub> -60:K <sub>2</sub> O-30:S-30:Zn-5:B-2 kg ha <sup>-1</sup> )	131.8	138.4	23.80	23.83	48.81	75.31	38.91	39.68
T <sub>4</sub> - Indo Gulf Customized fertilizer (Vardan) @ 250 kg ha + N-115 kg	128.0	134.4	23.60	23.65	48.33	73.94	39.70	39.37
T <sub>5</sub> - Tata Chemical Limited customized fertilizer (Paras) 250 kg/ha+ N-115 kg	124.1	130.3	23.20	23.22	47.50	72.58	39.59	39.52
T <sub>6</sub> Farmers' practices (N-100, P <sub>2</sub> O <sub>5</sub> -40, K-0, ZnSO <sub>4</sub> -10 kg/ha)	94.0	98.7	22.80	22.83	28.36	44.57	38.61	39.12
SEm±	3.07	3.23	0.60	0.60	0.830	2.306	0.87	0.95
C.D. at 5%	9.27	9.74	1.82	1.83	2.490	6.920	NS	NS

**Table 5:** Effect of customized fertilizer on availability of N, P, K, S, Zn and B nutrient in soil

Treatment	N (kg ha <sup>-1</sup> )		P (kg ha <sup>-1</sup> )		K (kg ha <sup>-1</sup> )		S (ppm)		Zn (ppm)		B (ppm)	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
T <sub>1</sub> –Control (No fertilizer application)	144.80	146.26	13.80	13.05	238.64	232.76	8.91	8.06	0.55	0.51	0.45	0.41
T <sub>2</sub> –Recommended dose of fertilizer (RDF) (N-150: P <sub>2</sub> O <sub>5</sub> -60: K <sub>2</sub> O - 60:ZnSO <sub>4</sub> -25 kg/ha)	173.65	172.22	17.90	18.50	258.00	261.60	12.32	11.96	0.66	0.61	0.46	0.45
T <sub>3</sub> –Soil Test Based on Recommendation (STR) (N-140:P <sub>2</sub> O <sub>5</sub> -60:K <sub>2</sub> O-30:S-30:Zn-5:B-2 kg ha <sup>-1</sup> )	176.00	176.12	18.90	19.35	254.60	256.10	14.70	15.06	0.63	0.67	0.54	0.56
T <sub>4</sub> - Indo Gulf Customized fertilizer (Vardan) @ 250 kg ha + N-115 kg	171.10	169.00	18.20	18.66	250.10	253.10	13.20	13.86	0.62	0.68	0.48	0.52
T <sub>5</sub> - Tata Chemical Limited customized fertilizer (Paras) 250 kg/ha+ N-115 kg	175.04	171.92	18.00	19.06	256.24	252.86	11.70	11.65	0.64	0.65	0.56	0.54
T <sub>6</sub> Farmers' practices (N-100, P <sub>2</sub> O <sub>5</sub> -40, K-0, ZnSO <sub>4</sub> -10 kg/ha)	153.16	154.29	15.60	14.96	242.00	240.27	9.40	8.90	0.56	0.53	0.44	0.43
SEm±	2.546	3.03	0.34	0.30	3.01	3.90	0.57	0.41	0.01	0.01	0.006	0.01
C.D. at 5%	7.64	9.09	1.03	0.926	9.03	11.71	1.71	1.23	0.04	0.05	0.02	0.03

**Table 6:** Effect of customized fertilizer on economics of various treatments

Treatments	Net return (Rs. ha <sup>-1</sup> )		Benefit : cost ratio	
	2014	2015	2014	2015
T <sub>1</sub> –Control (No fertilizer application)	6241	418	0.19	0.16
T <sub>2</sub> –Recommended dose of fertilizer (RDF) (N-150: P <sub>2</sub> O <sub>5</sub> -60: K <sub>2</sub> O -60:ZnSO <sub>4</sub> -25 kg/ha)	17491	19960	0.37	0.42
T <sub>3</sub> –Soil Test Based on Recommendation (STR) (N-140:P <sub>2</sub> O <sub>5</sub> -60:K <sub>2</sub> O-30:S-30:Zn-5:B-2 kg ha <sup>-1</sup> )	32204	34968	0.74	0.84
T <sub>4</sub> - Indo Gulf Customized fertilizer (Vardan) @ 250 kg ha + N-115 kg	29607	30841	0.72	0.69
T <sub>5</sub> - Tata Chemical Limited customized fertilizer (Paras) 250 kg/ha+ N-115 kg	28736	29051	0.70	0.65
T <sub>6</sub> Farmers' practices (N-100, P <sub>2</sub> O <sub>5</sub> -40, K-0, ZnSO <sub>4</sub> -10 kg/ha)	2316	6846	0.06	0.18

## Conclusion

Based upon the experimental results it can be concluded that maximum yield of rice and availability of macro and micro nutrients in soil were recorded with Soil Test based treatment which was significantly higher over all the treatments except customized fertilizers. These soil test based fertilizer application can be adjudged to the best treatment in terms of yield and B: C ratio and it helps to minimize the cost of fertilizer application.

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