



Evaluation of forage qualities of sorghum (*Sorghum bicolor* L.) under varying jeevamrit formulations and their spraying interval

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ABSTRACT

An experiment was conducted at ICAR-Central Institute for Research on Goats, Makhdoom to generate precise information about different jeevamrit formulation and their spraying interval on forage quality of fodder sorghum during summer season of 2022. The treatments consisted of three jeevamrit formulations viz. jeevamrit-1 (5 kg cow dung + 2.5 litre cow urine), jeevamrit-2 (10 kg cow dung + 5 litre cow urine) and jeevamrit-3 (15 kg cow dung + 7.5 litre cow urine); and three spraying intervals viz. spraying at every one week's interval, spraying at every two week's interval and spraying at every three week's interval. The experiment was laid out in factorial randomized block design with three replications. The results showed that among the different jeevamrit formulations, jeevamrit-3 and among the different spraying intervals, spraying at every one week's interval recorded maximum total dry matter yield, crude protein, ether extract, TDN content, dry matter intake, relative feed quality, net energy for lactation, nitrogen, phosphorus and potassium content in forage sorghum. However, among the different jeevamrit formulations, jeevamrit-2 and jeevamrit-3; and among the different spraying intervals, spraying of jeevamrit at every one week and every two week's interval recorded at par values of all the nutritive parameters in fodder sorghum.

Keywords: Forage quality, Jeevamrit, Natural farming, Proximate constitutes, RFQ

Sorghum (*Sorghum bicolor* L.) is an important forage crop of northern India and it has great potential for fodder production under limited resource conditions (Mohammed 2010). It is mostly grown by the farmers due to its higher forage dry matter production potential and cherished by livestock because of its good palatability as compared to other forage crops. Due to increasing human and livestock population, the demand for food and fodder is increasing, thus the crops are presently grown under intensive system of cultivation. But, indiscriminate and disproportionate use of chemical fertilizers and pesticides in this intensive agriculture practices led to soil toxicity, diminishing water resources, soil salinity, loss of soil fertility, global warming and increased incidence of human and livestock diseases (Rahman 2015). The use of high levels of chemical fertilizers on grasslands has enormous adverse effects on animal health and creates fertility problems e.g. high level of potassium can lead to reduction in fertility and reduced feed intake; and high level of nitrate during pregnancy has been linked to milk fever and other diseases (Lampkin 1990).

With the negative effects of these chemical fertilizers and pesticide on soil, animal and human health, some farmers are now thinking to practice the methods which

improve beneficial microorganism in soil to improve soil, animal and human health. So, Natural Farming or Zero Budget Natural Farming which discouraged to buy market based inputs like chemical fertilizers and pesticides, and advocate to enhancing beneficial microorganism in soil may be a feasible approach for these farmers. In this farming, jeevamrit is claimed as a panacea and it is reported that consortium of beneficial micro-organisms in jeevamrit converts the nutrients which are in non-available form into dissolved form, when it is inoculated to the soil (Kaur *et al.* 2021). Jeevamrit enhances microbial activity in soil and helps in improvement of soil fertility (Joshi 2012). However, the information related to application of jeevamrit in field crops particularly in forage crops is very meager. Hence, there is a felt need to generate precise information on preparation of different jeevamrit formulation and their frequency of application in forage crops.

MATERIALS AND METHODS

An experiment was undertaken to evaluate the effect of different jeevamrit formulations and their spraying interval on forage quality of fodder sorghum during summer season of 2022 at agriculture farm, ICAR-Central Institute for Research on Goats, Makhdoom, Mathura (Uttar Pradesh). The soil of the experimental field was neutral in reaction (pH 7.2) with EC of 0.24 dS/m. The soil was low in organic carbon (0.27%), medium in available nitrogen (256 kg/ha) and potassium (159 kg/ha); and high in available

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phosphorus (38 kg/ha). The treatments consist of three jeevamrit formulations viz. jeevamrit-1, jeevamrit-2 and jeevamrit-3 (details given in table 1); and three spraying intervals viz. spraying at every one week's interval, spraying at every two week's interval and spraying at every three week's intervals. The experiment was laid out in factorial randomize block design with three replications. The field was allocated into 27 plots and each plot was 3.6 m × 7.5 m in size. The details of preparation of different jeevamrit formulations are given in Table 1.

Table 1. Quantity of ingredients used for preparation of different jeevamrit formulation

Jeevamrit formulation	Ingredients
Jeevamrit-1	5 kg cow dung + 2.5 litre cow urine + 2 kg pulse flour + 2 kg jaggery + one hand full of soil + 200 litre water
Jeevamrit-2	10 kg cow dung + 5 litre cow urine + 2 kg pulse flour + 2 kg jaggery + one hand full of soil + 200 litre water
Jeevamrit-3	15 kg cow dung + 7.5 litre cow urine + 2 kg pulse flour + 2 kg jaggery + one hand full of soil + 200 litre water

*For preparation of different jeevamrit formulations, dung and urine were collected from Indian cow, in pulse flour besan (chickpea flour) and in jaggery gur is used after dissolving, one handful of soil was collected from fertile field and all these components were dissolved in 200 litre of water in plastic drum. **Different jeevamrit formulations were used at the 5th day of their preparation for spraying.

Sorghum variety MP Chari was sown on 24th March, 2022 with row to row spacing of 30 cm by using the seed rate of 25 kg/ha. The seeds were treated with beejamrit before the sowing. The beejamrit was prepared by using the 5 kg cow dung + 5 litre cow urine + 50 g lime + one hand full of soil in 20 litres of water. The spraying of jeevamrit was done as per the treatments.

Harvesting of sorghum was done twice, first harvesting was done at 55 days after sowing and second harvesting was done at 51 days after first harvesting.

The oven dried sample of sorghum were grounded and used for proximate analysis. The crude protein (%) of sample was calculated by multiplying the N content with the factor 6.25. Ether extract (EE) was analyzed by Soxhlet's extraction apparatus (AOAC 2005). Ash was determined by placing the sample in muffle furnace for ignition at 550°C for 2-3 h (AOAC, 2005). Neutral detergent fibre (NDF) and acid detergent fibre (ADF) were analyzed as described by Van Soest *et al.* (1991) and AOAC (2005), respectively. Total digestible nutrients (TDN), digestible dry matter (DDM), dry matter intake (DMI), relative feed value (RFV) and net energy for lactation (NE_l) were estimated according to the following equations adapted from Horrocks and Vallentine (1999) whereas, relative feed quality (RFQ) adapted from Undersander *et al.* (2010).

$$\text{TDN} = -1.291 \times \text{ADF} + 101.35$$

$$\text{DMI} = 120/\% \text{NDF on dry matter basis}$$

$$\text{DDM} = 88.9 - (0.779 \times \text{ADF})$$

$$\text{RFV} = \text{DDM} \times \text{DMI} \times 0.775$$

$$\text{RFQ} = \frac{(\text{DMI, \% of BW}) \times (\text{TDN, \% of DM})}{1.23}$$

$$\text{NE}_l (\text{Mcal/kg}) = [1.044 - (0.0119 \times \text{ADF})] \times 2.205$$

Estimation of macro nutrients in forage sorghum was done by using Micro Kjeldahl method for nitrogen, Vanadomolybdate phosphoric method for phosphorus and Flame Photometric method for potassium (Richards 1968). All the data were subjected to statistical analysis by adopting appropriate method of analysis of variance as described by Gomez and Gomez (1984). The replicated means were subjected to ANOVA using MS excel (2010). The critical difference (CD) was found by using $p=0.05$ that shows the results those were significantly different.

RESULTS AND DISCUSSION

Dry matter yield: Different jeevamrit formulations and their spraying interval had significant effect on dry matter yield of forage sorghum (Table 2). The maximum total dry matter yield (10.79 t/ha) of forage sorghum was recorded with the application of jeevamrit-3. However, jeevamrit formulations-2 recorded at par value of dry matter yield (10.47 t/ha). The higher dry matter yield of forage sorghum with jeevamrit-3 might be due to their higher nutrient concentration and microbial population as compared to jeevamrit-1. Devakumar *et al.* (2008) reported the presence of many beneficial microorganisms viz. nitrogen fixers, phosphorus solubilizers, actinomycetes and fungi in jeevamrit. Further, among the treatments of different spraying interval, spraying of jeevamrit at every one week's interval recorded significantly highest total dry matter yield (10.89 t/ha) of forage sorghum. However, spraying of jeevamrit at every one week's interval and every two week's interval (10.48 t/ha) recorded at par value of dry matter yield in forage sorghum. The higher dry matter yield of forage sorghum at spraying of jeevamrit at every one week's interval might be due to the fact that frequent

Table 2. Effect of different jeevamrit formulations and spraying interval on dry matter yield of forage sorghum

Treatment	Dry matter yield (t/ha)		
	1 st Cut	2 nd Cut	Total
<i>Jeevamrit formulations (J)</i>			
Jeevamrit-1	7.28	2.50	9.78
Jeevamrit-2	7.77	2.70	10.47
Jeevamrit-3	7.98	2.81	10.79
SEm±	0.18	0.09	0.24
CD (p=0.05)	0.53	0.28	0.72
<i>Spray interval in weeks (I)</i>			
One week	8.04	2.85	10.89
Two weeks	7.77	2.71	10.48
Three weeks	7.22	2.45	9.67
SEm±	0.18	0.09	0.24
CD (p=0.05)	0.53	0.28	0.72
Interaction of J × I	NS	NS	NS

application of jeevamrit added more nutrients to the canopy of the plants which led to higher growth and yield of the plants. Kaur *et al.* (2021) recorded that application of jeevamrit (20%) at two week's interval recorded highest dry matter accumulation per square meter in wheat. Sutar *et al.* (2018) reported that application of jeevamrit @ 1000 litre/ha recorded significantly taller plants and higher number of branches per plant than the application of jeevamrit @ 500 litre/ha in cowpea.

Proximate chemical constitutes and their yield: Crude protein, ether extract, ash, NDF and ADF content of forage sorghum were significantly influenced by different jeevamrit formulations and their spraying interval (Table 3). Significantly highest crude protein (8.18% - 1st cut and 7.15% - 2nd cut), ether extract (2.14% - 1st cut and 1.83% - 2nd cut) and ash content (12.27% - 1st cut and 11.08% - 2nd cut), whereas significantly lowest NDF (62.42% - 1st cut and 64.14% - 2nd cut) and ADF (35.60% - 1st cut and 36.84% - 2nd cut) content were recorded with the application of jeevamrit-3. However, jeevamrit-2 recorded at par value of crude protein, ether extract, ash, NDF and ADF content with jeevamrit-3. The higher value of proximate chemical constitutes with jeevamrit-3 might be due to their higher nutrient concentration compared to jeevamrit-1 as it is an excellent source of nitrogen, phosphorus, potassium, natural carbon and lot of other micronutrients which are required for plant (Maity *et al.* 2020). Among the treatments of spraying interval, spraying of jeevamrit at every one week's interval recorded significantly highest crude protein (8.23% - 1st cut and 7.19% - 2nd cut), ether extract (2.15% - 1st cut and 1.84% - 2nd cut) and ash content (12.41% - 1st cut and 11.21% - 2nd cut); and significantly lowest NDF (62.32% - 1st cut and 64.08% - 2nd cut) and ADF (35.44% - 1st cut and 36.71% - 2nd cut) content of forage sorghum. However, spraying of jeevamrit at every one week's interval and every two week's interval recorded at par value of proximate chemical constitutes of forage sorghum.

According to Aulakh *et al.* (2013), jeevamrit prepared from the dung and urine of Indian cow contains 0.04, 0.04, 0.28 and 0.43 g/l of nitrogen, phosphorus, potassium and sulphur, hence the higher values of crude protein, ether extract and ash content at spraying of jeevamrit at every one week's interval might be due to the fact that frequent application of jeevamrit added more nutrients to the canopy of the plants which led to higher value of crude protein, ether extract and ash content in forage sorghum.

Similarly, yield of crude protein, ether extract, ash content was also significantly influenced by different jeevamrit formulations and their spraying interval (Supplementary Table 1). The highest value of total crude protein yield, total ether extract yield and total ash yield was recorded with the application of jeevamrit-3. However, jeevamrit-2 recorded at par values of yield of these parameters with jeevamrit-3. Further, spraying of jeevamrit at every one week's interval also recorded significantly highest value of total crude protein, total ether extract and total ash yield. However, spraying of jeevamrit at every one week's interval and every two week's interval recorded at par values of yield of these proximate chemical constitutes of forage sorghum. The higher yield of proximate chemical constitutes with the application of jeevamrit-3 and with the spraying of jeevamrit at every one week's interval might be due to higher values of crude protein, ether extract and ash content; and dry matter yield with these treatments as yield of these parameters are calculated by multiplying with respective dry fodder yield.

Fodder qualities and net energy for lactation: Comparative analysis of different jeevamrit formulations revealed that highest value of TDN content (55.39% - 1st cut and 53.79% - 2nd cut), dry matter intake (1.93% - 1st cut and 1.87% - 2nd cut), digestible dry matter (61.17% - 1st cut and 60.20% - 2nd cut), relative feed value (91.25% - 1st cut and 87.41% - 2nd cut), relative feed quality (86.69% - 1st cut and 81.93% - 2nd cut) and net energy for lactation

Table 3. Effect of different jeevamrit formulations and spraying interval on proximate chemical constitute of forage sorghum

Treatment	CP (%)		EE (%)		Ash (%)		NDF (%)		ADF (%)	
	1 st Cut	2 nd Cut	1 st Cut	2 nd Cut	1 st Cut	2 nd Cut	1 st Cut	2 nd Cut	1 st Cut	2 nd Cut
<i>Jeevamrit formulations (J)</i>										
Jeevamrit-1	7.88	6.79	2.05	1.69	11.76	10.49	65.12	67.08	37.16	38.70
Jeevamrit-2	8.11	7.05	2.11	1.77	12.07	10.84	63.67	65.55	36.04	37.43
Jeevamrit-3	8.18	7.15	2.14	1.83	12.27	11.08	62.42	64.14	35.60	36.84
SEm±	0.08	0.09	0.02	0.03	0.13	0.14	0.68	0.75	0.42	0.48
CD (p=0.05)	0.24	0.26	0.07	0.09	0.39	0.41	2.05	2.24	1.25	1.44
<i>Spray interval in weeks (I)</i>										
One week	8.23	7.19	2.15	1.84	12.41	11.21	62.32	64.08	35.44	36.71
Two weeks	8.10	7.05	2.11	1.77	12.08	10.86	63.46	65.32	36.07	37.39
Three weeks	7.85	6.75	2.04	1.68	11.61	10.33	65.43	67.37	37.29	38.87
SEm±	0.08	0.09	0.02	0.03	0.13	0.14	0.68	0.75	0.42	0.48
CD (p=0.05)	0.24	0.26	0.07	0.09	0.39	0.41	2.05	2.24	1.25	1.44
Interaction of J × I	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

CP: Crude protein; EE: Ether extract; NDF: Neutral detergent fiber; ADF: Acid detergent fiber.

(1.37 Mcal/kg–1st cut and 1.34 Mcal/kg–2nd cut) in forage sorghum were recorded with the application of jeevamrit-3. However, jeevamrit-2 recorded at par value of all these parameters with jeevamrit formulations-3. Among the treatments of spraying interval, spraying of jeevamrit at every one week's interval recorded significantly highest value of TDN content (55.60% - 1st cut and 53.95% - 2nd cut), dry matter intake (1.93% - 1st cut and 1.88% - 2nd cut), digestible dry matter (61.29% - 1st cut and 60.30% - 2nd cut), relative feed value (91.60% - 1st cut and 87.64% - 2nd cut), relative feed quality (87.18% - 1st cut and 82.26% - 2nd cut) and net energy for lactation (1.37 Mcal/kg–1st cut and 1.34 Mcal/kg–2nd cut) in forage sorghum (Table 4 and 5). TDN is a measure of apparent digestible energy. The maximum value of TDN content may be attributed due to minimum value of ADF contents in the respective treatments. According to Carmi *et al.* (2006), TDN content in forage is inversely related with ADF concentration in feed therefore, as concentration of ADF increases, there is a decline in TDN content which limits an animal's ability to utilize the nutrients that are present in the forage. Dry matter intake is negatively correlated with NDF, whereas digestible dry matter is negatively correlated with ADF. Horrocks and Vallentine (1999) also reported that where NDF is high, forage quality and dry matter intake are low. Relative feed value (RFV) is an index which is used to predict intake and energy value of forage which is derived from DMD and DMI (Lithourgidis *et al.* 2006). Differences in the digestibility of the fibre fraction can result in a difference in animal performance when forages with a similar RFV are fed. Therefore, the relative feed quality (RFQ) index has been developed to overcome this difference. According to Jeranyama and Garcia (2004), this index takes into consideration the differences in digestibility of the fibre fraction and can be used to predict more accurately animal performance and match

Table 4. Effect of different jeevamrit formulations and spraying interval on fodder qualities of forage sorghum

Treatment	TDN (%)		DMI (%)		DDM (%)	
	1 st Cut	2 nd Cut	1 st Cut	2 nd Cut	1 st Cut	2 nd Cut
<i>Jeevamrit (J)</i>						
Jeevamrit-1	53.37	51.38	1.84	1.79	59.95	58.75
Jeevamrit-2	54.82	53.02	1.89	1.83	60.82	59.74
Jeevamrit-3	55.39	53.79	1.93	1.87	61.17	60.20
SEm±	0.54	0.62	0.02	0.02	0.32	0.37
CD (p=0.05)	1.61	1.86	0.06	0.06	0.97	1.12
<i>Spray interval in weeks (I)</i>						
One week	55.60	53.95	1.93	1.88	61.29	60.30
Two weeks	54.78	53.08	1.89	1.84	60.80	59.77
Three weeks	53.21	51.17	1.84	1.78	59.85	58.62
SEm±	0.54	0.62	0.02	0.02	0.32	0.37
CD (p=0.05)	1.61	1.86	0.06	0.06	0.97	1.12
Interaction of J × I	NS	NS	NS	NS	NS	NS

TDN: Total digestible nutrients; DMI: Dry matter intake; DDM: Digestible dry matter.

Table 5. Effect of different jeevamrit formulations and spraying interval on relative feed value, quality and net energy for lactation of forage sorghum

Treatment	RFV (%)		RFQ (%)		NE _l (Mcal/kg)	
	1 st Cut	2 nd Cut	1 st Cut	2 nd Cut	1 st Cut	2 nd Cut
<i>Jeevamrit (J)</i>						
Jeevamrit-1	85.76	81.59	80.15	74.89	1.33	1.29
Jeevamrit-2	88.93	84.86	84.10	79.02	1.36	1.32
Jeevamrit-3	91.25	87.41	86.69	81.93	1.37	1.34
SEm±	1.06	0.98	1.20	1.10	0.01	0.01
CD (p=0.05)	3.17	2.92	3.58	3.29	0.03	0.04
<i>Spray interval in weeks (I)</i>						
One week	91.60	87.64	87.18	82.26	1.37	1.34
Two weeks	89.19	85.18	84.32	79.36	1.36	1.32
Three weeks	85.16	81.03	79.43	74.22	1.32	1.28
SEm±	1.06	0.98	1.20	1.10	0.01	0.01
CD (p=0.05)	3.17	2.92	3.58	3.29	0.03	0.04
Interaction of J × I	NS	NS	NS	NS	NS	NS

RFV: Relative feed value; RFQ: Relative feed quality; NE_l: Net energy for lactation.

animal needs. NE_l includes energy used for maintenance and milk production because energy is used with the same efficiency whether for milk production or for maintenance. Using databases containing the ADF content of feeds and the NE_l content of those feeds, regression equations have been developed to predict NE_l from the ADF content of a feed. According to Ondarza (2000) as ADF increases, NE_l decreases.

Content and uptake of macronutrients: Nitrogen, phosphorus and potassium content of forage sorghum was significantly influenced by different jeevamrit formulations and their spraying intervals (Table 6). The highest value of nitrogen (1.31% - 1st cut and 1.14% - 2nd cut), phosphorus (0.276% - 1st cut and 0.232% - 2nd cut) and potassium (1.96% - 1st cut and 1.61% - 2nd cut) content were recorded with the application of jeevamrit-3. However, jeevamrit-2 recorded at par values of N, P and K content with jeevamrit-3 in forage sorghum. The higher value of nutrient content with jeevamrit-3 might be due to their higher nutrient concentration compared to jeevamrit-1 as jeevamrit prepared from 10 kg of cow dung and 10 litre of cow urine contains 0.004, 0.004 and 0.028% (Aulakh *et al.* 2018), 0.077, 0.017 and 0.013 % (Gore and Sreenivasa 2011), 1.96, 0.173 and 0.280 % (Devakumar *et al.* 2014) of N, P and K, respectively. Among the treatments of spraying interval, spraying of jeevamrit at every one week's interval recorded significantly highest nitrogen (1.32% - 1st cut and 1.15% - 2nd cut), phosphorus (0.279% - 1st cut and 0.235% - 2nd cut) and potassium (1.97% - 1st cut and 1.62% - 2nd cut) content of forage sorghum. However, spraying of jeevamrit at every one week's interval and every two week's interval recorded at par value of N, P and K content in forage sorghum. Higher values of nitrogen, phosphorus and potassium content at spraying of jeevamrit

Table 6. Effect of different jeevamrit formulations and spraying interval on macronutrient contents in forage sorghum

Treatment	Nitrogen content (%)		Phosphorus content (%)		Potassium content (%)	
	1 st	2 nd	1 st	2 nd	1 st	2 nd
	Cut	Cut	Cut	Cut	Cut	Cut
<i>Jeevamrit (J)</i>						
Jeevamrit-1	1.26	1.09	0.260	0.212	1.88	1.51
Jeevamrit-2	1.30	1.13	0.270	0.224	1.94	1.59
Jeevamrit-3	1.31	1.14	0.276	0.232	1.96	1.61
SEm±	0.01	0.01	0.004	0.004	0.02	0.02
CD (p=0.05)	0.04	0.04	0.011	0.013	0.06	0.06
<i>Spray interval in weeks (I)</i>						
One week	1.32	1.15	0.279	0.235	1.97	1.62
Two weeks	1.30	1.13	0.272	0.226	1.94	1.59
Three weeks	1.26	1.08	0.255	0.206	1.86	1.50
SEm±	0.01	0.01	0.004	0.004	0.02	0.02
CD (p=0.05)	0.04	0.04	0.011	0.013	0.06	0.06
Interaction of J × I	NS	NS	NS	NS	NS	NS

at every one week's interval might be due to the fact that frequent application of jeevamrit added more nutrients to the canopy of the plants which led to higher value of N, P and K content in forage sorghum. Jeevamrit promotes immense biological activity in soil and enhance nutrient availability to crop (Gore and Sreenivasa 2011). According to Choudhary *et al.* (2022), higher phosphorus uptake is because of increased microbial activity which might have helped in solubilization of native and applied phosphorus and provided greater quantity of available phosphorus for plant uptake.

Similarly, uptakes of nitrogen, phosphorus and potassium were also significantly influenced by different jeevamrit formulations and their spraying interval (Supplementary Table 2). The highest value of total nitrogen, total phosphorus and total potassium uptake were recorded with the application of jeevamrit-3. However, jeevamrit-2 recorded at par values of uptake of these nutrients with jeevamrit-3. Further, spraying of jeevamrit at every one week's interval also recorded significantly highest value of total nitrogen, total phosphorus and total potassium uptake. However, spraying of jeevamrit at every one week's interval and every two week's interval recorded at par values of uptake of these nutrients in forage sorghum. The higher uptake of nutrients with the application of jeevamrit-3 and with the spraying of jeevamrit at every one week's interval might be due to higher values of N, P and K content; and dry matter yield with these treatments as uptake of these nutrients are calculated by multiplying the nutrient content with respective dry matter yield. According to Choudhary *et al.* (2022) jeevamrit have important role in increasing nutrient concentration in plant and dry matter yield through the increased availability and solubility of nutrients in soil and thus enhancing their accumulation and transportation in plant.

The research findings revealed that in forage sorghum

highest value of dry matter yield; proximate chemical constitutes and their yield; fodder quality and net energy for lactation; and contents and uptakes of macro nutrients were recorded with the application of jeevamrit-3 and among spraying interval spraying at every one week's interval. However, among the different formulations, jeevamrit-2 and jeevamrit-3; and among the different spraying interval spraying of jeevamrit at every one week's interval and every two week's intervals recorded at par values all these parameters in forage sorghum. Hence, this study recommended application of jeevamrit-2 at every two week's intervals for higher yield, crude protein and fodder qualities in forage sorghum.

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