Original Research Article

Enhancing Growth and Yield of *Parching* Sorghum Through Organic Manure Application

ABSTRACT

Aims: The combination of various sources of organic manures along with liquid organic manures is important to maintain nutrient availability to crop and sustain higher level of soil fertility. The aim is to meet the nutrient demand of *parching* sorghum as per requirement at different stages through solid and liquid organic manures which can give greater productivity of crops.

Study Design: The experiment was laid in Randomized Complete Block Design with 9 treatments replicated thrice.

Place and Duration of Study: A field experiment was conducted at College of Agriculture, Vijayapur, during Rabi, 2020-21.

Methodology: The treatments were T_1-Ghanajeevamrutha based on 100% RDN(recommended dose of Nitrogen) as basal dose, T_2-Vermicompost based on 100% RDN as basal dose, T_3- T_1 + foliar application of 10% vermiwash at 20 & 45 DAS(days after sowing), T_4- T_1 + foliar application of 10% cow urine at 20 & 45 DAS, T_5- T_1 + foliar application of 25% jeevamrutha at 20 & 45 DAS, T_6-T_2 + foliar application of 10% vermiwash at 20 & 45 DAS, T_7-T_2 + foliar application of 10% cow urine at 20 & 45 DAS, T_8-T_2 + foliar application of 25% jeevamrutha at 20 & 45 DAS and T_9-Organic RPP of *parching* sorghum with SMJ-1 variety of *parching* sorghum.

Results: The application of ghanajeevamrutha based on 100 per cent RDN as basal dose+ foliar application of 25 per cent jeevamrutha at 20 and 45 days after sowing recorded significantly higher dry matter production (55.86 g plant^{-1}), leaf area index (3.49), raw and roasted grain weight (39.49 g and 51.73 g respectively), raw and roasted grain yield (1063 kg ha^{-1} and 1505 kg ha^{-1} respectively) of *parching* sorghum (*hurda*) at harvest as compared to other treatments. In addition to improvement in the major plant nutrient uptake were recorded with incorporation of ghanajeevamrutha or vermicompost along with the liquid organic manure.

Conclusion: The application of ghanajeevamrutha based on 100 per cent RDN as basal dosecoupled with foliar application of 25 per cent jeevamrutha at 20 and 45 days after sowing recorded significantly higher growth, yield, quality and plant nutrient uptake by *parching* sorghum.

Key words: *Parching sorghum, Hurda, Organics, Ghanajeevamrutha, Vermiwash*

1. INTRODUCTION

Sorghum [*Sorghum bicolor*(L.) Moench] commonly known as jowar, is an ancient cereal grain belonging to the grass family Poaceae (Graminaceae). It holds a prominent position among cereal crops, ranking after wheat, rice, maize, and barley. Sorghum plays a crucial role in providing food for millions of people residing in semiarid tropics. In India, sorghum is one of the staple food crops of many states like Maharashtra, Karnataka, Madhya Pradesh, Tamil Nadu, Gujarat and cultivated in nutrient-poor soils in frequently drought-prone areas, it offers food and fodder security through risk aversion on sustainable basis.Sorghum has good nutritional composition similar to rice and wheat in some aspects. The grains contain high fiber and non-starchy polysaccharides and starch with some unique characteristics. There is a considerable variation in sorghum for levels of proteins, lysine, lipids, carbohydrates, fiber, calcium, phosphorus, iron, thiamine and niacin (Chavan et al., 2009). Protein quality and essential amino acid profile of sorghum is better than many of the cereals and millets. Sorghum in general is rich source of fiber and B-complex vitamins (Patil et al., 2010).

The tender jowar grains in English is called as *parching* Sorghum. Basically, the period during late winter when sorghum grain is juicy and very tender, panicle is roasted over cakes of dried cow dungthen roasted *hurda* hold in bare palms, vigorous rubbing to separate roasted *hurda* from the chaff.*Hurdas*commonly eaten with the hull, which retains most of the nutrients and very high in fiber and iron, with a fairly high protein content and also a good source of phosphorus and thiamine.Hurda is rich in antioxidants and all sorghum varieties are gluten-free, an attractive alternative for wheat allergy sufferers.*Parching* sorghum is rich in dietary fiber. A single serving of this provides the dietary fiber by 48 per cent of the daily recommended value. This assist in preventing the health conditions such as bloating, cramping, stomach aches, constipation, diarrhea and excess gas. The high amount of fiber helps to eliminate LDL cholesterol level which upgrades the heart health and also prevents heart attacks, atherosclerosis and strokes (Porter *et al*., 1977). Sorghum can be a gluten free diet option for celiac patients (Ciacci *et al*., 2007).

Prolonged use of chemical fertilizers causes an increase in pest and kills the beneficial microbes present in the soil. Chemical fertilizers are highly soluble in water hence they leach away into groundwater without fully benefiting the plant. Thus, fewer nutrients are available for the plant.Organic systems use 45 per cent less energy than conventional systems. Production efficiency is 28 per cent higher in the organic systems, while the conventional no-till system being the least efficient in terms of energy usage. The soil and climatic conditions in the drylands are well adapted to organic farming.When organic fertilizers are applied, soil microorganisms themselves degrade them until they become water soluble compounds that plants take advantage from. Thus, organic fertilizers improve soil structure, help to retain nutrients, allow carbon fixation in the substrate and enhance the ability of the crop to absorb water.Now a days agro-tourism business is increasing in the rural areas and in the contest of supplying sorghum *hurda*as a niche product get the more profit to the farmers and producers (Taylor *et al*., 2006). Hence, the current study was intended to find the response of organic manures on growth, yield, quality and plant nutrient uptake by *parching* sorghum.

2. MATERIAL AND METHODS

The experiment was conducted at College of Agriculture, Vijayapur, situated in the Northern Dry Zone of Karnataka (Zone 3), at 16^0 49' North latitude, 75^0 43' East longitude and at an altitude of 593.8 m above the mean sea level. The soil was low in organic carbon (0.37%), low in available nitrogen (188 kg ha^{-1}), high in both available phosphorus (29.5 kg ha^{-1}) and available potassium (390 kg ha^{-1} high).During the cropping period of 2020-21, a total rainfall of 865.5 mm was received in 51 rainy days from April 2020 to March 2021 as against the normal rain of 594.4 mm which was received in 38 rainy days. The maximum monthly temperature over the years (1981-2019) was the highest in the month of May (39.6℃), while it was the lowest in the month of December (29.1℃). The normal monthly mean minimum temperature was the lowest in the month of January (14.6℃).

2.1 Experimental design and treatment combination

The field experiment was laid out in Randomized Complete Block Design with 9 treatments (T_1-Ghanajeevamrutha based on 100% RDN as basal dose, T_2-Vermicompost based on 100% RDN as basal dose, T_3-T_1 + foliar application of 10% vermiwash at 20 & 45 DAS, T_4- T_1 + foliar application of 10% cow urine at 20 & 45 DAS, T_5- T_1 + foliar application of 25% jeevamrutha at 20 & 45 DAS, T_6-T_2 + foliar application of 10% vermiwash at 20 & 45 DAS, T_7-T_2 + foliar application of 10% cow urine at 20 & 45 DAS, T_8-T_2 + foliar application of 25% jeevamrutha at 20 & 45 DAS and T_9-Organic RPP of *parching* sorghum) and 3 replications.

2.2 Crop management

After the previous crop was harvested, the ground was ploughed once again and planking was done in both the direction to prepare a levelled and fine seed bed. The total quantity of ghanajeevamrutha and vermicompost were calculated based on their respective nitrogen content in order to meet the recommended dose of N (40 kg ha^{-1}). The variety SMJ-1 was used after treatment with biofertilizers and dried under the shade. Sowing was done on 20th October with the spacing of 45×15 cm. Intercultivation was done to remove all weeds from the field in order to check crop weed competition.

2.3 Observations

Observation on dry matter production leaf area index were taken on 30, 60 days after sowing and at harvest.

$$LAI = \frac{\text{Leaf area}}{\text{Ground surface area}}$$

Harvesting was done when crop had attained milky dough stage. The sorghum heads from net plot were cut, panicles were subjected for baking in cow dung fire for 5 min. Then the roasted sorghum grains were separated by hand by holding the panicle in both the hands and then rubbing it with palm. The raw and roasted grains were weighed. The stalks were separately weighed after drying which is useful green fodder for cattle. Using the formula suggested by Donald (1962), the ratio of economic yield to biological yield was computed.The yield attributes and yield observations were recorded from the net plots and grain yield was converted to hectare basis in kilograms.The quality parameter like sugar content of grainsdone by using hand refractometer and nutrient uptake by both grains and straw was also computed.

$$\text{Nutrient uptake (kg ha}^{-1}\text{)} = \frac{\text{Nutrient content (\%) x Grain or fodder yield (kg ha}^{-1}\text{)}}{100}$$

The data collected from the experiment at different growth stages and at harvest were subjected to statistical analysis as described by Gomez and Gomez (1984). The level of significance used for 'F' and 't' tests was P=.05. Critical Difference (CD) values were calculated at 5 per cent probability level if the F test was found to be significant.

3. RESULTS AND DISCUSSION

3.1 Growth Parameters

3.1.1 Dry matter production

The dry matter production per plant of *parching* sorghum did not differ significantly at 30 DAS under different treatments. At 60 DAS and at harvest significantly higher dry matter production per plant was observed with the application of ghanajeevamrutha based on 100 per cent RDN as basal dosecoupled with foliar application of 25 per cent jeevamrutha at 20 & 45 DAS (26.03 g plant^{-1} and 55.86 g plant^{-1} respectively) (Table 1).

3.1.2 Leaf area index

There was no significant difference in leaf area index at 30 DAS. But at 60 DAS and at harvest, it was observed that ghanajeevamrutha based on 100 per cent RDN as basal dose+ foliar application of 25 per cent jeevamrutha at 20 & 45 DAS registered significantly higher leaf area index (3.71 and 3.49) compared to other treatments(Table 1).

This increment was mainly due to the combined addition of organics which helped in better photosynthetic capacity of plant which inturn increased translocation of photosynthates to the sink.This was main tool for getting higher dry matter production and accumulation, grain and stalk yield of the crop.Kasbe*et al.* (2009) also reported similar results that supply of jeevamrutha at 10638 l ha^{-1} produced significantly higher total dry matter in rice which is in conformity to the parallel findings of Reshma *et al.* (2019).

3.2 Yield parameters

3.2.1 Grain weight per plant

Raw and roasted *hurda*grains per plant at harvest differed significantly among the treatments. Application of ghanajeevamrutha based on 100 per cent RDN as basal dose+ foliar application of 25 per cent jeevamrutha at 20 & 45 DAS recorded significantly higher raw grain weight per plant (39.49 g and 51.73 g respectively) compared to other treatments (Table 2).

3.2.2 Grain yield

Increase in raw grain yield and roasted grain weight was noticed with infusion of ghanajeevamrutha based on 100 per cent RDN as basal doseplus foliar application of 25 per cent jeevamrutha at 20 & 45 DAS (1063 kg ha^{-1}, 1505 kg ha^{-1}, 5932 kg ha^{-1} and 3318 kg ha^{-1} respectively) over other treatments (Table 2).

This increment in panicle weight and grain yield was mainly due to inclusion of organic manures as well as jeevamrutha as a foliar spray which improved the soil health, so that plants got benefited with the balanced level of nutrition which led to higher yield. Significant enhancement in the growth and yield parameters of foxtail millet can be seen on application of jeevamrutha + mulching + compost + vermicompost + panchagavya treatment over control as reported by Upendranaik *et al*. (2018) which is in conformity to the similar findings of Boraiah*et al*. (2017).

3.3 Seed quality parameter

3.3.1 Total sugars (%)

Total sugars in grains of *parching* sorghum did not differ significantly but higher with supply of ghanajeevamrutha based on 100 per cent RDN as basal dosecoupled with foliar application of 25 per cent jeevamrutha at 20 & 45 DAS (13.77%) (Table 2).
This higher total sugars in grains might be attributed to the incorporation of organics and foliar spray of jeevamrutha which led to more availability of N in soil and for absorption. El-Hoda and El-Koliey (1999) observed that the brix percent, sucrose percent, juice and syrup yield increased with increasing N rates.

Table 1: Dry matter production and leaf area index of *parching* sorghum as influenced by different organic sources

Treatments	Dry matter production (g plant^{-1})			Leaf area index		
	30 DAS	**60 DAS**	**At harvest**	**30 DAS**	**60 DAS**	**At harvest**
T_1: Ghanajeevamrutha based on 100% RDN as basal dose	2.56	18.74	45.02	0.40	2.76	2.22
T_2: Vermicompost based on 100% RDN as basal dose	2.45	18.17	43.67	0.39	2.73	2.11
T_3: T_1 + foliar application of 10% vermiwash at 20 & 45 DAS	2.72	20.66	48.59	0.41	3.17	2.62
T_4: T_1 + foliar application 10% cow urine at 20 & 45 DAS	2.89	22.43	50.03	0.46	3.28	2.93
T_5: T_1 + foliar application 25% jeevamrutha at 20 & 45 DAS	3.13	26.03	55.86	0.55	3.71	3.49
T_6: T_2 + foliar application 10% vermiwash at 20 & 45 DAS	2.65	19.92	48.12	0.41	3.14	2.45
T_7: T_2 + foliar application 10% cow urine at 20 & 45 DAS	2.88	21.84	49.89	0.42	3.24	2.80
T_8: T_2 + foliar application 25% jeevamrutha at 20 & 45 DAS	3.11	25.18	54.99	0.51	3.69	3.40
T_9: Organic RPP of *parching* sorghum	2.59	19.89	46.31	0.40	2.95	2.32
SEm±	**0.22**	**0.75**	**1.78**	**0.04**	**0.12**	**0.09**
CD (*P*=.05)	**0.66**	**2.24**	**5.35**	**0.11**	**0.37**	**5.78**

Note: RDN- Recommended dose of Nitrogen DAS- days after sowing
RPP- Recommended package of practice

Table 2: Grain weight per plant, grain yieldand total sugars in grain of *parching* sorghum as influenced by different organic sources

Treatments	Grain weight per plant (g)		Grain yield (kg ha^{-1})		Total sugars (%)
	Raw	Roasted	Raw	Roasted	
T_1: Ghanajeevamrutha based on 100% RDN as basal dose	27.74	819	819	77.43	13.05
T_2: Vermicompost based on 100% RDN as basal dose	24.43	804	804	76.07	12.93
T_3: T_1 + foliar application of 10% vermiwash at 20 & 45 DAS	32.89	907	907	81.66	13.21
T_4: T_1 + foliar application 10% cow urine at 20 & 45 DAS	33.62	936	936	82.89	13.34
T_5: T_1 + foliar application 25% jeevamrutha at 20 & 45 DAS	39.49	1063	1063	93.68	13.77
T_6: T_2 + foliar application 10% vermiwash at 20 & 45 DAS	31.08	884	884	79.59	13.12
T_7: T_2 + foliar application 10% cow urine at 20 & 45 DAS	32.70	924	924	82.05	13.26
T_8: T_2 + foliar application 25% jeevamrutha at 20 & 45 DAS	38.86	1045	1045	92.46	13.60
T_9: Organic RPP of *parching* sorghum	28.43	853	853	79.75	12.47
SEm±	**1.5**	**42**	**42**	**3.81**	**0.34**
CD (*P*=.05)	**4.49**	**127**	**127**	**11.42**	**1.03**

Note: RDN- Recommended dose of Nitrogen; RPP- Recommended package of practices; DAS- days after sowing

3.4 Plant nutrient uptake

Significantly higher uptake of N by grains and fodder was observed with incorporation of ghanajeevamrutha based on 100 per cent RDN as basal doseplus foliar application of 25 per cent jeevamrutha at 20 & 45 DAS (47.72 kg ha^{-1} and 37.76 kg ha^{-1} respectively), uptake of P_2O_5 by grains and fodder was higher with vermicompost based on 100 per cent RDN as basal dosecoupled with foliar application of 25 per cent jeevamrutha at 20 & 45 DAS (6.84 kg ha^{-1} and 15.74 kg ha^{-1} respectively), whereas higher uptake of K_2O was observed with vermicompost based on 100 per cent RDN as basal doseplus foliar application of 10 per cent cow urine at 20 & 45 DAS (32.75 kg ha^{-1} and 81.07 kg ha^{-1} respectively) (Figure 1).

This increment observed in uptake was mainly because of combined application of organic manures along with liquid organic manures which helped in enhancement of available nutrient status of the soil there by support the root for better uptake of nutrients. There is a slow and steady rate of nutrients release pattern which was observed in incubation study might be another reason for higher uptake of nutrients by the crop. These outcomes are in agreement with the findings of Shete *et al.* (2011) who revealed that total nitrogen and phosphorus uptake in greengram was directly proportional to the application of FYM at 5 t ha^{-1}.

4. CONCLUSION

The application of ghanajeevamrutha (2963 kg ha^{-1}) based on 100 per cent RDN as basal dosecoupled with foliar application of 25 per cent jeevamrutha at 20 and 45 days after sowing recorded significantly higher dry matter production, leaf area index, grain weight, grain yield of *parching* sorghum (*hurda*) at harvest as compared to other treatments. In case of plant nutrient uptake application of ghanajeevamrutha based on 100 per cent RDN as basal dosecoupled with foliar application of 25 per cent jeevamrutha at 20 and 45 DAS to *parching* sorghum recorded significantly higher uptake of N, application of vermicompost (4 tha^{-1}) based on 100 per cent RDN as basal dosecoupled with foliar application of 25 per cent jeevamrutha at 20 and 45 DAS to *parching* sorghum recorded significantly higher uptake of P_2O_5 and application of vermicompost based on 100 per cent RDN as basal doseplus foliar application of 10 per cent cow urine at 20 and 45 DAS to *parching* sorghum recorded significantly higher uptake of K_2O.With this context the conclusion can be drawn that nutrient management options involving organic manures and liquid organic manures has potential to recover soil fertility and crop yield on sustainable basis as they supply almost all the essential nutrients, increasing nutrient use efficiency and improves soil physical, chemical and biological properties and inturn resulted in increase in crop yield and productivity.

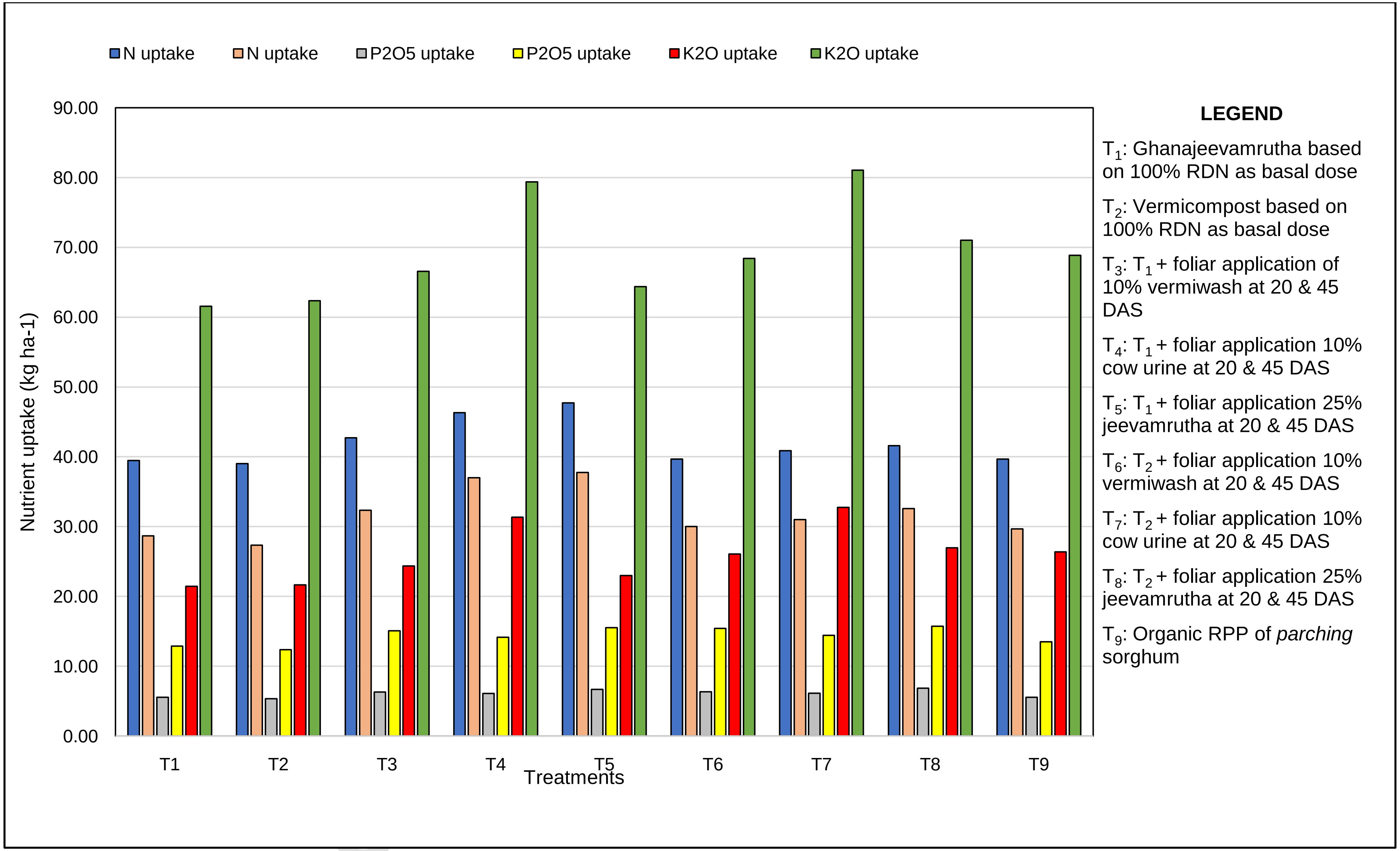

Fig 1: N, P_2O_5 and K_2O uptake of *parching* sorghum as influenced by different organic sources

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