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STANDARDIZATION OF PROPAGATION TECHNIQUES IN JAMUN [*Syzygium cumini* (L.) Skeels] UNDER PUNJAB CONDITIONS

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ABSTRACT

The present investigation was carried at Punjab Agricultural University, Regional Fruit Research Station, Bahadurgarh, Patiala during 2020-21. Jamun cv. Konkan Bahadauli was used as scion and *desi* jamun seedlings as rootstock. Plants were propagated by five different propagation techniques viz., wedge grafting, side grafting, T-budding, patch budding and inarching in the months of January, February, March, May, June, July and August. The plants propagated by wedge grafting technique in the month of February and July had graft survival of 76.67 and 70.00 per cent, respectively. Early bud sprouting was recorded in wedge grafting. The maximum average plant height four months after grafting was recorded in inarching technique (90.66 cm) followed by wedge grafting (53.24 cm). It was concluded that wedge grafting should be done during the month of February and July for successful propagation of jamun under Punjab conditions.

Keywords: Inarching, Propagation, *Syzygium cumini*, Wedge grafting

Jamun [*Syzygium cumini* (L.) Skeels] is an important minor fruit crop grown in the tropical and subtropical regions across the globe. It belongs to *Myrtaceae* family, indigenous to Indian sub continental. Though considered as minor fruit, but it is gaining popularity among consumers due to its nutritional and medicinal values. Its growing area is extended from Burma to Afghanistan. In India, it is mainly found in the states like Maharashtra, Gujarat, Punjab, Haryana, U P, Jharkhand, Rajasthan, M P, Bihar, Chhattisgarh, Karnataka, A P, Kerala and Tamil Nadu (Singh *et al.,* 2011).

Jamun has wider adaptability owing to its hardy nature and it can tolerate drought and heavy rainfall (Chovatia and Singh, 2000).Every part of the plant is economically important like fruit, seed, bark and leaves which can be utilized for different purposes. The fruit pulp contains so many biochemical compounds such as anthocynins, proteins, phenols, etc. The fruit is very helpful for the diabetic patients owing to the presence of jamboline and ellagic acid which prevent the conversion of starch into sugar (Patel *et al.,* 2005). The ripened fruits are used for table purpose and processed into various value added products. The fruit syrup is a remedy for diarrhea (Sah and Verma, 2011). The vinegar made from fruit extract of unripe fruits has cooling effect and is beneficial for digestive system (Chaudhary and Mukhopadhyay, 2012).

Jamun is polyembryonic in nature so true to type plants can be multiplied by seeds as well as vegetative means, but the plants multiplied by the seeds have very long juvenile phase and vigorous growth which makes fruit harvesting and other cultural operations difficult. So the propagation by this means is not advocated for commercial multiplication and cultivation (Muniyappan *et al.,* 2019). Most of the jamun trees existing in India have seedling origin so there is lot of variability owing to cross-pollination (Anon., 2007). The demand of jamun fruit is increasing day by day and hence growers are fetching remunerative prices in the market. To meet the demand of true to type elite planting material, the present investigation was planned with the objective of standardizing the propagation techniques and time under North Indian conditions.

MATERIALS AND METHODS

The investigation was carried out at Punjab Agricultural University, Regional Fruit Research Station, Bahadurgarh, Patiala during the year 2020-21. Each treatment had 30 plants, replicated thrice with 10 plants per replication. This experiment was carried out in Randomized Block Design. In this experiment, jamun cultivar 'Konkan Bahadauli' was used as scion whereas 18 months old seedlings of *Desi* jamun were grown in polythene bags of size 25×30 cm kept under polyhouse. Plants with uniform growth and pencil thickness were used as rootstock. About 10-15 cm of long scion sticks were used for wedge grafting and the propagation was performed at the height of 15-20 cm above the ground level. The propagation was done by the five different techniques viz., wedge grafting, T-budding, side grafting, patch budding and inarching carried out during the months of January, February, March, May, June, July and August. Important parameters such as percent

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graft survival, days to bud sprouting, leaf area and days taken from grafting to plant sale were recorded. The growth parameters like plant height, shoot length (longest shoot), number of shoots, stock girth (10 cm above base), scion girth and number of leaves were recorded at 120 days after grafting. The data was statistically analyzed with SAS software (p≤0.05). The meteorological data pertaining to experimental area is given in Fig. 2.

RESULTS AND DISCUSSION

Days to bud sprouting

The average number of days taken from propagation to bud sprouting among different methods for propagation showed significant variation and average values ranged from 17.04 to 28.14 days (Table 1). The plants grafted through wedge grafting took least number of days to sprouting whereas the T-budded plants took maximum days for bud sprouting.

Among various months of grafting, the plants grafted during the month of June took shortest period for sprouting (17.75 days),while plants propagated in January took longer period for sprouting (36.16 days). This wide variation may be attributed to the variable climatic conditions prevailing during different months. High temperature during June promotes quick sprouting due to fast bud union formation while delayed sprouting during January may be due to low temperature which led to decline in callus formation. Kumar *et al.* (2018) also observed rapid sprouting (14.00 days after grafting) in softwood grafted jamun plants under open and closed conditions.

Graft survival

The graft survival in propagation studies is an important parameter that governs the success or failure of the nursery production and its economic viability in vegetatively propagated plants. The data presented in Table 2 and Fig.1 reveal that the there was a significant difference for this parameter depending upon technique as well as time of propagation. The average survival percentage among various propagation techniques ranged from 18.10 to 61.27 per cent. The highest average values were recorded in the inarching followed by wedge grafting while least values were recorded in side grafting. The highest mean survival percentage among different months of grafting was recorded in plants propagated during the month of July (46.00%) which was statistically at par with August (42.12%),

Table 1. Effect of various propagation techniques and months of grafting on days to bud sprouting (days) in jamun cv. Konkan Bahadauli

Treatment	Days to bud sprouting							Mean
	January	February	March	May	June	July	August	
Wedge grafting	26.00	19.00	15.00	14.00	15.00	14.00	15.00	17.04
Patch budding	50.00	38.00	23.00	20.00	20.00	22.00	23.00	28.00
T-budding	44.00	38.00	38.00	18.00	14.00	22.00	23.00	28.14
Side grafting	25.00	30.00	26.00	23.00	21.00	22.00	24.00	24.38
Mean	36.16	31.25	25.50	18.75	17.75	20.00	21.33	
LSD (p≤0.05)	Treatments (A) :0.89 Months (B) :1.18 (A×B) :2.36							

Table 2. Effect of various propagation techniques and months of grafting on graft survival percentage in jamun cv. Konkan Bahadauli

Treatment	Per cent graft survival							Mean
	January	February	March	May	June	July	August	
Wedge grafting	66.67	76.67	40.00	16.67	20.00	70.00	66.67	50.00
Patch budding	13.33	16.67	16.67	53.33	36.67	30.00	36.67	29.05
T-budding	16.67	20.00	13.33	23.33	30.00	36.67	27.27	23.90
Side grafting	13.33	13.33	13.33	13.33	10.00	30.00	33.33	18.10
Inarching	60.00	70.00	65.56	53.33	70.00	63.33	46.67	61.27
Mean	32.67	39.33	29.78	32.00	33.33	46.00	42.12	
LSD (p≤0.05)	Treatments (A) : 6.73 Months (B) : 7.96 (A×B) : 17.80							

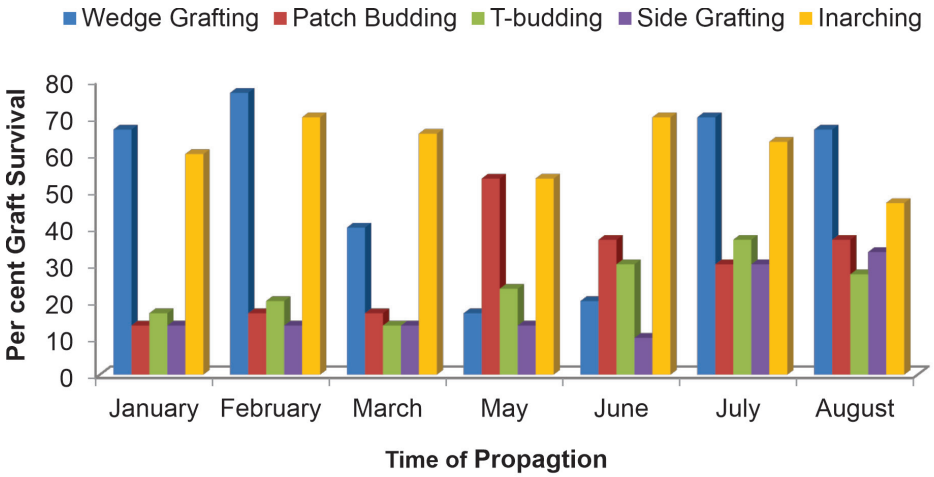

Fig. 1. Effect of various propagation techniques and months of grafting on graft survival percentage in jamun cv. Konkan Bahadauli

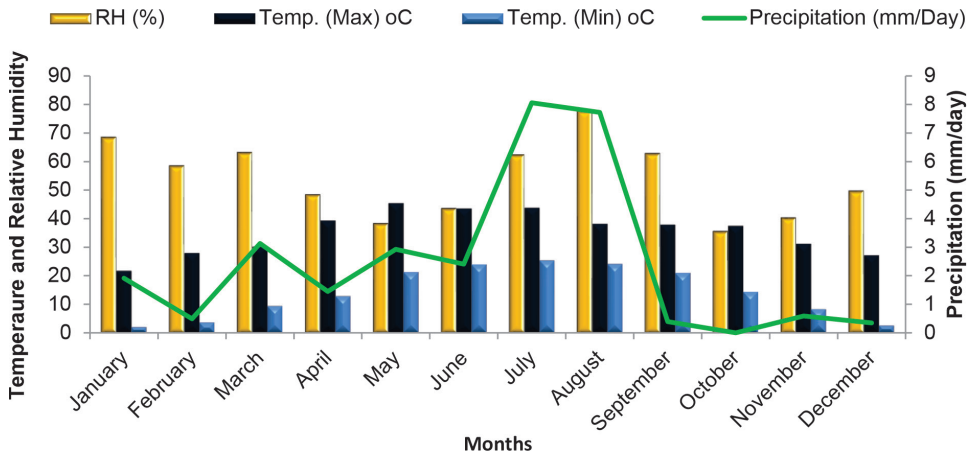

Fig. 2. Average monthly meteorological data of the experimental area during the year 2020-21.

whereas the least average survival rate was recorded for the month of March (29.78%).

The plants propagated by wedge grafting during the month of February were recorded with highest (76.67 %) graft survival followed by plants grafted through same technique during July (70.00%) and inarching during February and June (70 % each). The success of wedge grafting in jamun mainly depends upon the scion bud availability. Generally one year old shoots without active growth were found suitable for wedge grafting hence high success rates were observed when scion sticks were taken before flowering and after fruit harvesting of the mother plants i.e. in the months of February and July. Ghojage *et al.* (2011) also observed maximum survival percentage in the month of February (81.66%) with the softwood (wedge) grafting in jamun. Bharad and Mahorkar (2011) recorded maximum graft survival in soft wood grafting during the month of March followed by September and low graft success in patch budded plants. Gadekar *et al.* (2010) also reported March and September as best time for jamun propagation through softwood grafting.

Plant height (cm)

The values pertaining to plant height measured after 120 days of grafting are presented in Table 3. Among the various propagation methods, the maximum average plant height to the tune of 83.79 cm was recorded in plants propagated by inarching technique followed by wedge grafting (53.24 cm) whereas the minimum average plant height was measured in patch budded plants (34.00 cm). With respect to months of propagation, the average values for this trait ranged from 41.84 cm to 55.48 cm. The maximum values were recorded in the plants which were propagated in the month of February which was at par with months of March, May and June while the least values were recorded for the month of August. Sharma (2021) observed the maximum plant height of 93.78 cm 120 days after grafting in jamun plants propagated by wedge

Table 3. Effect of various propagation techniques and months of grafting on plant height (cm) 120 days after grafting in jamun cv. Konkan Bahadauli

Treatment	Plant height (cm)							Mean
	January	February	March	May	June	July	August	
Wedge grafting	52.90	67.40	60.10	47.70	60.30	46.80	37.50	53.24
Patch budding	34.10	33.20	37.06	38.70	35.06	31.80	28.10	34.00
T-budding	37.10	40.40	38.50	44.10	43.30	32.70	29.88	37.99
Side grafting	42.56	46.10	41.60	46.20	42.80	41.10	34.40	42.11
Inarching	80.00	90.30	86.06	86.80	85.80	78.30	79.30	83.79
Mean	49.33	55.48	52.66	52.70	53.45	46.14	41.84	
LSD (p≤0.05)	Treatments (A) : 2.41 Months (B) : 2.85 A×B : 6.38							

grafting during the second week of August.

Shoot length (cm)

Maximum average shoot length (47.78 cm) was observed in patch budding followed by the T-budding (42.41cm) whereas the minimum (36.75 cm) was observed in inarching which was at par with the side grafting (37.18 cm) (Table 4). The average shoot length among various months of propagation showed significant differences and the values varied from 23.96 to 54.59 cm for plants grafted in the month of August and June, respectively. The values for this parameter with respect to January, February and July propagated plants showed non-significant variation.

The maximum shoot growth in patch and T-budded plants may be due to single bud sprout and hence a smaller number of shoots per plant as compared to other techniques which have multiple bud sprouting after grafting. Jamun plants propagated in May show highest shoot length and diameter due to high C:N ratio in both scion and stock whereas the plants prepared during February contained highest soluble nitrogen in scion and less carbohydrates (Chovatia and Singh, 2000).

Number of shoots per graft

The values pertaining to numbers of shoots per graft, 120 days after grafting, are presented in the Table 5. The average values for the parameter as influenced by different methods of propagation ranged from 1.64 shoots per graft in T-budding to 4.30 shoots per graft in Inarching followed by wedge grafting (3.34 shoots per graft). Muniyappan *et al.* (2019) reported maximum numbers of shoots (6.13) in the plants propagated by softwood grafting in jamun. Among different months of propagation, the maximum average shoot numbers were observed in plants grafted during March followed by January which were statistically at par with each other. The highest numbers of shoots (5.50) were recorded in plants propagated by inarching method done in the month of August.

Table 4. Effect of various propagation techniques and months of grafting on Shoot length (cm) 120 days after grafting in jamun cv. Konkan Bahadauli

Treatment	Shoot length (cm)							Mean
	January	February	March	May	June	July	August	
Wedge grafting	31.05	34.44	51.41	52.67	54.13	34.45	16.4	39.22
Patch budding	38.47	42.52	57.51	60.81	67.27	41.65	26.2	47.78
T-budding	40.72	38.58	52.67	54.90	57.15	30.22	22.6	42.41
Side grafting	31.95	32.62	47.49	46.12	55.12	30.17	16.81	37.18
Inarching	37.27	29.77	40.80	32.70	39.30	39.6	37.8	36.75
Mean	35.89	35.59	49.98	49.44	54.59	35.22	23.96	
LSD (p≤0.05)	Treatments (A) : 1.15 Months (B) : 1.37 (A×B) : 3.05							

Table 5. Effect of various propagation techniques and months of grafting on number of shoots per graft in jamun cv. Konkan Bahadauli

Treatment	Number of shoots per graft							Mean
	January	February	March	May	June	July	August	
Wedge grafting	3.20	3.50	4.10	3.70	2.60	3.10	3.20	3.34
Patch budding	2.10	1.50	2.00	3.33	2.00	1.67	1.60	2.02
T-budding	2.10	1.60	1.90	1.60	1.33	1.67	1.33	1.64
Side grafting	2.50	1.70	2.50	1.80	2.60	3.10	1.67	2.26
Inarching	4.80	3.60	4.50	3.60	4.10	4.00	5.50	4.30
Mean	2.94	2.38	3.00	2.80	2.52	2.70	2.66	
LSD (p≤0.05)	Treatment (A) : 0.15 Month (B) : 0.18 (A×B) : 0.40							

Stock girth (mm)

The stock girth values varied significantly for different techniques and times of grafting as well as interaction of both (Table 6). The average rootstock girth for the different propagation techniques varied from 33.72 to 41.17 mm. The maximum stock girth was measured in the plants propagated by the inarching method followed by patch budding (36.78 mm) whereas the minimum in plants propagated by the T-budding. Among various months of grafting, the highest average stock girth was measured in plants propagated during the month of February (38 mm) which was at par with the month of January (37.46 mm), June (37.40 mm) and March (36.64 mm) whereas the least values were recorded in August grafted plants (35.02 mm).The maximum girth of stock to the tune of 46.30 mm was observed in plants propagated during July by inarching method and this was followed by June (46.10 mm) and values were at par with each other.

Scion girth (mm)

The average values regarding the scion girth among different propagation techniques ranged from 20.20 to 26.33 mm in side grafting and inarching, respectively (Table 7). The scion girth with respect to different time of treatment ranged between 19.60 mm and 23.06 mm in plants multiplied in August and May months, respectively. In case of wedge grafting, the maximum scion girth was noticed in the May month and lowest in the August while in patch budding the maximum girth was recorded in the March (23.40 mm) whereas least in the August i.e 15.30 mm. Rani *et al.* (2015) also reported the maximum scion girth in the plants which were propagated by the wedge grafting technique.

Number of leaves per plant

Number of leaves per graft i.e. 120 days after grafting showed significant variation with respect to technique, time as well as combined influence of both (Table 8). The maximum average values for this parameter among different propagation methods were recorded for plants propagated by inarching (29.36 leaves per graft) which was at par with wedge grafted plants (29.24 leaves per graft). The minimum average

Table 6. Effect of various propagation techniques and months of grafting on stock girth (mm) in jamun cv. Konkan Bahadauli

Treatment	Stock girth (mm)							Mean
	January	February	March	May	June	July	August	
Wedge grafting	38.00	42.00	41.00	32.00	30.30	38.10	32.00	35.62
Patch budding	32.00	35.00	36.00	41.00	36.30	37.60	39.60	36.78
T-budding	39.00	35.00	32.00	38.00	37.00	29.60	32.50	33.72
Side grafting	39.00	41.00	33.00	32.00	37.30	35.00	36.00	36.18
Inarching	39.30	41.00	41.20	39.30	46.10	46.30	35.00	41.17
Mean	37.46	38.00	36.64	36.46	37.40	35.92	35.02	
LSD (p≤0.05)	Treatments (A) : 1.33 Months (B) : 1.58 (A×B) : 3.54							

Table 7. Effect of various propagation techniques and months of grafting on scion girth (mm) in jamun cv. Konkan Bahadauli

Treatment	Scion girth (mm)							Mean
	January	February	March	May	June	July	August	
Wedge grafting	22.70	23.40	22.43	23.60	21.10	18.60	18.10	21.42
Patch budding	22.10	21.30	23.40	20.40	21.20	18.90	15.30	20.37
T-budding	23.10	24.10	20.10	21.60	22.90	17.40	15.40	20.66
Side grafting	19.30	19.40	19.90	21.50	22.40	19.03	19.90	20.20
Inarching	23.30	23.30	27.50	28.23	27.40	25.30	29.30	26.33
Mean	22.10	22.30	22.66	23.06	23.00	19.85	19.60	
LSD (p≤0.05)	Treatments (A) : 0.56 Months (B) : 0.66 (A×B) : 1.47							

numbers of leaves per graft (19.33) were counted in T-budded plants.

While comparing various months of propagation, it was noted that the average values for number of leaves per graft ranged from 16.46 for January to 29.33 for the month of May which was statistically at par with the month of June with 28.82 leaves per graft. The maximum numbers of leaves per graft were counted in plants propagated by wedge grafting technique done during the month of May while minimum in T-budding done during February month. Mulla *et al.* (2011) reported highest number of leaves per plant (12.48) in jamun propagated by the softwood grafting during the month of June under controlled conditions.

Leaf area (cm²)

The maximum leaf area was observed in the plants which were propagated by the inarching method with an average of 67.82 cm^2 which was at par with the wedge grafted plants (Table 9). The maximum average leaf area among different times of propagation was recorded in the plants propagated in the month of July (66.36) which was at par with the propagation done in the month of August. While minimum area was recorded in the month of May i.e 58.82 cm^2. Considering the time and methods of propagation, in wedge grafting the maximum leaf area was recorded in the plants which were propagated in the month of August and it was at par with the plants propagated in the month of May and February. In patch and T-budding, the maximum leaf area was observed in the month of July i.e. 67.50 and 65.40 cm^2 , respectively. In inarching method, the maximum leaf area was observed in the month of March (82.10 cm^2). Muniyappan *et al.* (2019) observed the maximum area of leaves (32.88 cm^2) in the jamun plants which were propagated by the softwood grafting in the month of August under mist conditions.

Days taken from grafting to plant sale

The wedge grafted plants became ready for the sale after 163.71 days of grafting while the plants propagated by patch budding technique took average 179.00 days for plant sale (Table 10). With respect to the time of propagation, the maximum days taken from

Table 8. Effect of various propagation techniques and months of grafting on number of leaves per graft in jamun cv. Konkan Bahadauli

Treatment	Number of leaves per graft							Mean
	January	February	March	May	June	July	August	
Wedge grafting	20.00	22.50	35.30	36.67	34.60	20.33	16.30	29.24
Patch budding	13.10	12.50	20.67	25.60	28.60	16.60	13.70	20.82
T-budding	12.90	12.30	19.33	24.30	24.30	17.60	15.60	19.33
Side grafting	15.20	14.50	26.83	29.80	27.30	19.10	17.33	23.44
Inarching	21.10	27.33	33.80	30.30	29.30	35.60	28.10	29.36
Mean	16.46	17.83	27.19	29.33	28.82	21.85	18.21	
LSD (p≤0.05)	Treatments (A) :1.20 Months (B) :1.43 (A×B) :3.20							

Table 9. Effect of various propagation techniques and months of grafting on leaf area (cm^2) in jamun cv. Konkan Bahadauli

Treatment	leaf area (cm^2)							Mean
	January	February	March	May	June	July	August	
Wedge grafting	63.60	70.30	65.10	72.20	57.20	68.00	72.40	66.97
Patch budding	61.30	45.80	53.10	46.10	65.00	67.50	58.60	56.77
T-budding	61.50	46.20	52.60	45.50	64.20	65.40	56.80	56.02
Side grafting	60.40	68.50	63.40	70.10	56.10	66.50	70.40	65.05
Inarching	61.10	75.80	82.10	60.20	59.90	64.40	71.30	67.82
Mean	61.58	61.32	63.26	58.82	60.48	66.36	65.90	
LSD (p≤0.05)	Treatment (A) : 0.90 Month (B) : 1.06 (A×B) : 2.38							

Table 10. Effect of various propagation techniques and months of grafting on number of days taken from grafting to plant sale in jamun cv. Konkan Bahadauli

Treatment	Days taken from grafting to plant sale							Mean
	January	February	March	May	June	July	August	
Wedge grafting	137.00	127.00	115.00	106.00	101.00	290.00	270.00	163.71
Patch budding	156.00	145.00	128.00	116.00	110.00	312.00	286.00	179.00
T-budding	159.00	148.00	121.00	113.00	112.00	307.00	281.00	177.29
Side grafting	140.00	129.00	112.00	110.00	104.00	310.00	275.00	168.57
Inarching	132.00	135.00	140.00	132.00	125.00	280.00	265.00	172.71
Mean	144.80	136.80	123.20	115.40	110.40	299.80	275.40	
LSD (p≤0.05)	Treatments (A) : 2.46 Months (B) : 2.91 (A×B) : 6.51							

grafting to sale were observed in the month of July i.e. 299.80 days followed by August with 275.40 days taken for plant sale while least time was taken by the plants which were propagated in the month of June i.e. 110.4 days which were at par with the month of May. The smaller number of days taken for plant sale for May and June grafted plants may be due to early bud sprouting and fast growth owing to congenial environment during subsequent growth period. Whereas the growth of plants slowed down in following winter season and plants resumed growth in following spring season. The plants grafted by wedge grafting during the month of June took minimum days (101.00) for plant sale after grafting which was at par with plants which were propagated by same method in May month.

To conclude, the wedge grafting could be adopted for successful propagation of jamun under Punjab conditions in the month of February and July as it has maximum survival percentage. Despite high graft survival and plant height, the inarching method is not advisable for commercial nursery production as it is cumbersome, labour intensive and graft union is prone to breakage when compared to other propagation techniques.

Authors' contribution

Conceptualization of research work and designing of experiments (RSB, DSG); Execution of field/lab experiments and data collection (RS); Analysis of data and interpretation (RS, RSB, DSG); Preparation of manuscript (RS, DSG, RSB)

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