

## STUDIES ON SUITABILITY OF GRAFTING UNDER DIFFERENT GROWING SEASONS IN GUAVA (*PSIDIUM GUAJAVA* L.)

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**Abstract:** The current investigation was carried out to study the suitability of different methods of grafting under different growing seasons in guava for year round production of quality planting material. The experiment was carried out at the College Orchard, TNAU, Coimbatore during the year 2018-19. The experiment was carried out using FRCD with three replications. Different methods of grafting viz., approach grafting (G<sub>1</sub>), wedge grafting (G<sub>2</sub>) and side grafting (G<sub>3</sub>) at three different seasons of grafting viz., Oct-Nov, 2018 (S<sub>1</sub>), Feb- March, 2019 (S<sub>2</sub>) and June- July, 2019 (S<sub>3</sub>) were experimented. The study showed that there was great scope for clonal multiplication of guava through grafting techniques. The results of the experiment indicated that, among the three methods of grafting, Wedge grafting performed during the month of Oct-Nov, 2018 (G<sub>2</sub>S<sub>1</sub>) registered lesser days taken for bud sprouting (19 days), first leaf emergence (24.70 days), highest graft success percentage (82.65) and increased leaf area (44.04cm<sup>2</sup>) as compared to other methods of grafting. Likewise, wedge grafting done during the month of June-July, 2019 (G<sub>2</sub>S<sub>3</sub>) exhibited improved graft survival percentage (72.28), highest sprout length (11.11cm) and no. of leaves per graft (30.5). With regard to the biochemical parameters, wedge grafting performed during June-July, 2019 (G<sub>2</sub>S<sub>3</sub>) recorded highest chlorophyll content (24.40 SPAD unit), photosynthetic rate (16.26 μmol CO<sub>2</sub> m<sup>-2</sup> s<sup>-1</sup>) and lowest phenol contents (3.16 mg g<sup>-1</sup>). Microtome studies also indicated a strong graft union in wedge grafted plants.

**Keywords:** Guava, Grafting methods and season, Graft success and survival percentage, Chlorophyll, Phenols, Microtome studies

### INTRODUCTION

Guava (*Psidium guajava* L.), popularly known as the “Apple of tropics” belongs to the family Myrtaceae and is one of the most promising fruit crops, sharing about 4.1% of total fruit production in India. The fruit is also a good source of pectin, calcium and phosphorus. Besides its high nutritional value, guava bears heavy crop every year and gives good economic returns (Singh *et al.*, 2000). Guava is quite hardy, prolific bearer and highly remunerative crop. Uttar Pradesh leads in area under guava cultivation (45.00 thousand ha) whereas Madhya Pradesh leads in terms of production (841.1 thousand MT) and productivity (37.6 MT/ ha) (Tiwari *et al.*, 2014). The leading guava producing states include Madhya Pradesh, Uttar Pradesh, Bihar, Maharashtra, West Bengal, Punjab, Chhattisgarh, Karnataka, Gujarat, Haryana, Andhra Pradesh, etc. Commercial cultivation is delimited with several identified constraints like- propagation problems, guava wilt, fruit fly infestation and availability of quality planting material. The greatest handicap in guava plantation is indiscriminate multiplication of plants from unreliable sources by nurserymen. Though guava is successfully propagated through budding (Kaundal *et al.*, 1987), air-layering (Manna *et al.*, 2004) and stooling (Pathak and Saroj, 1988), they are still not commercially viable due to varying rates of success, absence of tap root system and cumbersome process. Though multiplication of guava through grafting has incredible potential for rapid multiplication throughout the year both under protected and open conditions, studies suitability of

different methods of grafting under different growing seasons are quite scanty. Success in grafting, subsequent growth of scion shoot and development of the successful graft depend on number of factors including variety, time of grafting, method of grafting, selection and preparation of scion, rootstock material and environmental conditions. Hence the present research was undertaken to standardize the best method of grafting performed during particular season of the year based on their biometric and biochemical observations.

### MATERIALS AND METHODS

The current investigation was carried out at the College Orchard, Department of Fruit Crops, TNAU, Coimbatore during 2018-19. Pre-raised guava seedlings of uniform age (8 to 10 months) and size (pencil thickness) were purchased from private nursery and used as rootstock for grafting purpose. The pre-cured scion (Lucknow 49) free from pest and diseases were selected from College Orchard and used for grafting purpose. The scion was prepared by defoliation of past season leaves 7 to 10 days prior to the grafting operation to activate the dormant buds. The scion shoots were collected from mother tree during early morning hours (7 to 9 am) on the day of grafting. The guava plants were subjected different grafting methods under different season of grafting for mass multiplication. The treatment details are given below;

#### Factor A: Grafting methods

G<sub>1</sub> - Approach grafting

G<sub>2</sub> - Wedge grafting

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G3 - Side grafting

**Factor B: Season of grafting**

S1 - Oct- Nov, 2018

S2 - Feb- March – 2019

S3 - June-July, 2019

Replication : Three

Design : Factorial Completely  
Randomized Design (FCRD)

The grafts were taken care along with proper irrigation and weeding in beds. The sprouts on rootstocks were removed, regularly. The polyethylene caps were removed when the grafts produced new flushes of growth from the axillary buds of the scion. In order to achieve maximum graft success the grafted plants were watered daily except those in mist chamber. In nursery, drenching of 0.1% per cent Bordeaux mixture was given at monthly interval to protect from root rot diseases. Prophylactic spray of monocrotophos at the rate 1.5 ml / litre spray was given to control sucking pest and leaf eating caterpillar. Sprouts arising from below the graft union were removed periodically. After two months of grafting operation, the polyethylene strip was removed from the graft joint.

All the experimental grafts were observed daily critically for recording the data on days taken for sprouting, days taken for first leaf emergence, graft success percentage, graft survival percentage, sprout length, number of leaves per graft and leaf area was recorded.

$$\text{Graft success percentage (\%)} = \frac{\text{No. of sprouted grafts}}{\text{Total plants grafted}} \times 100$$

$$\text{Survival percentage (\%)} = \frac{\text{No. of plants survived}}{\text{Number of plants grafted}} \times 100$$

The biochemical parameters viz., chlorophyll content, photosynthetic rate and total phenols were recorded at 120 days after grafting. SPAD readings were recorded using chlorophyll meter (SPAD 502) designed by the Soil Plant Analytical Development (SPAD) section, Minolta, Japan. The chlorophyll fluorescence was measured using the fluorescence meter (Plant PAM-210 (Teaching PAM) (Schreiber *et al.*, 2003). Likewise, Folin ciocalteau reagent method was followed for estimating the total phenols Bray and Thrope (1954).

Microtome study was taken up to analyze the ultra-structure change and compatibility in the grafted plants, under the microscope anatomical observation was performed according Johansen (1940). Data collected on graft bud sprouting, graft success and growth attributes of grafted plants were subjected to statistical analysis by the mean comparisons with Least Significance Difference (LSD) values with  $p < 0.05$ . All the statistical analyses were achieved utilizing the statistical analysis software AGRES.

## RESULTS AND DISCUSSION

### Growth parameters

All the growth parameters observed were significantly influenced by the various methods of grafting performed at different seasons of the year. Among the different methods of grafting, wedge grafting was found to produce successful graft union considering all contributing growth parameters. Wedge grafting done during the month of Oct - Nov, 2018 (G<sub>2</sub>S<sub>1</sub>) resulted in early bud sprouting (19.00 days), lesser number of days taken for first leaf emergence (24.70 days). Whereas longer days were reported for days taken for bud sprouting (23.67) and days taken for first leaf emergence (31.60) in side grafted plants performed during June - July 2019 (G<sub>3</sub>S<sub>3</sub>). It could be attributed to the successful interlocking of parenchymatous cells between the stock and scion along with establishment of cambial region of both stock and scion under favourable environmental conditions like relatively higher temperature and relative humidity during the month of Oct - Nov promoted better and early sprouting (Table 1). It could be attributed to the fact that optimum temperature and water availability increased the rate of photosynthesis leading to the production of more food material that facilitates improved growth and development of graft sprouts. These results are in consonance with the earlier findings by Singh and Pandey (1998) and Joshi *et al.*, (2014) in guava.

Significant differences were observed for graft success percentage with regard to method of grafting and season of grafting. The maximum graft success (77.39%) was noted in wedge grafting (G<sub>2</sub>) and minimum graft success (61.07%) was noted in side grafting (G<sub>3</sub>). Among the different seasons of grafting, maximum graft success (73.75%) was observed in plants grafted during Oct- Nov, 2018 (S<sub>1</sub>) and minimum graft success (66.35%) was found during grafting during Feb- March, 2019 (S<sub>2</sub>) which was on par with June- July, 2019 (S<sub>3</sub>) (Table 1). Relative humidity and temperature plays a significant role for graft success percentage in a particular season. After grafting, stored auxins in scion gets accumulated on graft union due to basipetal movement leading to early cambial tissue development and quick graft healing to make strong and successful graft union. This helps to uptake water and nutrient from soil, synthesis of more amount of photosynthates, increase the transport of water and nutrient leading to faster growth of grafts. Similar finding was reported by Saroj (1988) and Munthaj (2014) in guava.

Graft survival percentage revealed significant difference for different grafting methods and season of grafting and their interaction effects (Table 1). The highest graft survival percentage (72.28) was noticed in wedge grafted plants during the month of June-July, 2019 (G<sub>2</sub>S<sub>3</sub>) closely followed by G<sub>2</sub>S<sub>1</sub> (70.56).

It could be attributed to many factors including maximum degree of wound surface exposed to scion and rootstock, quick and strong union formation, better compatibility of the scion-stock combination and better nutrient uptake during June-July would have facilitated easy graft union. Moreover, favourable micro-climatic conditions along with congenial environment within the plant tissues, especially the cambium, would have been the probable reason for comparatively improved graft survival percentage. These results are in agreement with the findings of Anushma *et al.*, (2014) in Jamun and Kalabandi *et al.*, (2014) in Sapota.

Wedge grafting performed during different seasons of the year significantly affected the sprout length, number of leaves per sprout and leaf area at 120 DAG. Maximum sprout length (11.11cm), number of leaves per graft (30.50) and leaf area (44.04 cm<sup>2</sup>) was registered in wedge grafted plants performed during June-July, 2019 followed by those grafted during Oct-Nov, 2018. While the lowest values for above characters was observed in side grafted plants during all the seasons. The quick and strong union formation, better compatibility of the scion-stock combination and better nutrient uptake could mainly be attributed to high cell activity inducing temperatures during June-July that might have positively influenced these plant growth parameters. These results are also in accordance with the findings of Joshi *et al.* (2014) who reported that 'Local guava' rootstock + wedge grafting + polyhouse with polycap combination produced higher number of leaves and more leaf area per graft. The present findings also got support from other findings of Rani (2010) and Anil (2013) in guava.

#### **Biochemical parameters**

The biochemical parameters such as chlorophyll content, net photosynthetic rate and total phenol content were greatly influenced by the different methods and seasons of grafting. In the present study, wedge grafted plants exhibited higher chlorophyll content (24.32 SPAD unit) and photosynthetic rate (16.11  $\mu\text{mol CO}_2 \text{ m}^{-2} \text{ s}^{-1}$ ) as compared to approach and side grafted plants. Likewise the grafting done during the month of June-July, 2019 recorded increased values for chlorophyll (24.18 SPAD unit) content and photosynthetic rate (15.42  $\mu\text{mol CO}_2 \text{ m}^{-2} \text{ s}^{-1}$ ) (Table 2). Wedge grafting with more chlorophyll SPAD value are likely the most efficient and healthier among all the grafts as it has accumulated more amount of photosynthates during its growth period and had put forth better increase in all growth characteristics in guava. Photosynthesis, which plays a major role in carbon metabolism of a plant is a major driver of the all other metabolic process and helps in net assimilation rate thus increasing the biomass. Chlorophyll

fluorescence is the depiction of energy of the photochemical processes which gets re-emitted as light. In our present study, wedge grafting during February month showed a higher rate of photosynthesis and transpiration rate which helps in gaseous exchange leading to accumulation of more assimilates and produce more leaves leading to increment in biomass. Usually grafting influences most of the physiological and biochemical parameters viz., photosynthates, chlorophyll fluorescence and total chlorophyll which are the major contributors of the growth. The present findings are in consonance with the results of Joshi and Syamal (2014) in guava.

With regard to the total phenol content, side grafted plants performed during the month of Oct-Nov, 2018 recorded higher content (4.09 mg g<sup>-1</sup>) and the lowest (3.16 mg g<sup>-1</sup>) was registered in wedge grafted plants executed during June-July, 2019. Total phenol content in the grafts determines the degree of graft union and graft survival percentage. Higher the phenol content greater is the graft incompatibility, as the accumulation of phenols at the graft union block the auxin transport and reduces tissue permeability which could be attributed to reduced compatibility and success of grafts in saddle grafting recording higher phenol content. The results are in confirmation with the findings of Ding *et al.* (1998) in loquat and (Murti and Upreti, 2003) in mango.

#### **Anatomical studies**

A successful graft union is the result of cambial connectivity that occurs due to the proliferation of callus cells forming a bridge. Thus, it is important for any grafting studies to take into account the anatomical basis of graft union that occur during the course of grafting. In the present study, the cross section of graft union at different stages was examined on 60<sup>th</sup> and 90<sup>th</sup> day after grafting. In wedge grafted plants, the callus got proliferated and filled all spaces and differentiation was visible only during 90<sup>th</sup> days after grafting (Fig. 1). The success of grafting depends upon the compatibility of the stock and scion which are clearly understood from the above anatomical studies. The results are supported by the work of (Dolgun *et al.*, 2008) in apple Chakrabarty and Sadhu (1989) in mango.

From the above investigation, it can be concluded that wedge grafting performed during the month of Oct-Nov, 2018 resulted in lesser days for bud sprouting and first leaf emergence, higher graft success percentage. Likewise, wedge grafting done during June-July, 2019 resulted in improved graft survival percentage, sprout length, number of leaves, leaf area and increased chlorophyll and rate of photosynthesis and lowest values for total phenol content.

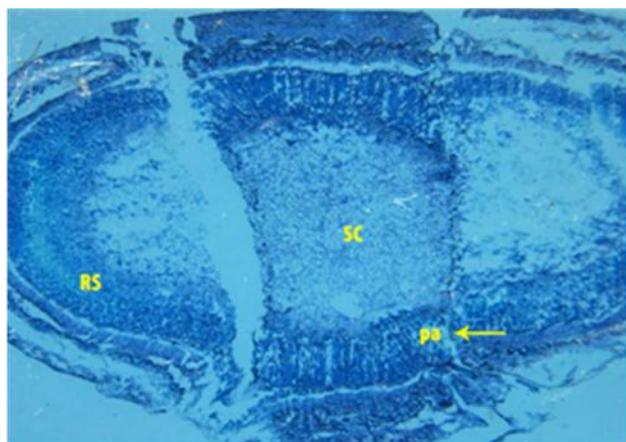
**Table 1.** Effect of different grafting methods and season of grafting on different growth parameters of guava

Treatments	Days taken for bud sprouting	Days taken for first leaf emergence	Graft success percentage	Graft survival percentage	Sprout length (cm) (120 DAG)	No. of leaves/graft (120 DAG)
<b>Method of grafting (G)</b>						
Approach grafting (G1)	21.89	28.07	69.48	60.48	9.88	25.69
Wedge grafting (G2)	20.67	26.43	77.39	67.84	10.70	29.48
Side grafting (G3)	23.11	30.97	61.07	50.29	8.94	23.29
S <sub>Ed</sub>	1.52	0.42	0.33	0.47	0.22	0.50
CD@5%	0.29	2.01	0.67	0.95	0.44	1.00
<b>Season of grafting (S)</b>						
Oct- Nov 2018 (S <sub>1</sub> )	20.67	26.69	73.75	60.94	10.06	26.50
Feb- March 2019 (S <sub>2</sub> )	22.56	29.59	66.35	56.01	9.45	25.28
June-July 2019 (S <sub>3</sub> )	22.44	29.19	67.83	61.65	10.02	26.68
S <sub>Ed</sub>	0.17	0.52	0.41	0.58	0.27	0.61
CD@5%	0.35	2.01	0.82	1.17	0.54	<b>1.22</b>
<b>Method of grafting x Season of grafting (SxG)</b>						
Approach grafting + Oct- Nov 2018 (G1S1)	20.67	25.2	74.50	62.20	9.97	25.4
Approach grafting + Feb- March 2019 (G1S2)	22.33	29.2	68.45	58.60	9.66	25.1
Approach grafting + June-July 2019 (G1S3)	22.67	29.8	65.50	60.63	10.01	26.5
Wedge grafting + Oct- Nov 2018 (G2S1)	19.00	24.7	82.65	70.56	10.86	29.7
Wedge grafting + Feb- March 2019 (G2S2)	22.00	28.4	71.25	60.68	10.12	28.3
Wedge grafting + June-July 2019 (G2S3)	21.00	26.2	78.26	72.28	11.11	30.5
Side grafting + Oct- Nov 2018 (G3S1)	22.33	30.1	64.10	50.05	9.34	24.4
Side grafting + Feb- March 2019 (G3S2)	23.33	31.2	59.36	48.76	8.55	22.4
Side grafting + June-July 2019 (G3S3)	23.67	31.6	59.74	52.05	8.94	23.0
S <sub>Ed</sub>	0.35	1.03	0.81	1.16	0.54	1.22
CD@5%	0.70	2.01	1.64	2.33	<b>1.08</b>	<b>2.45</b>

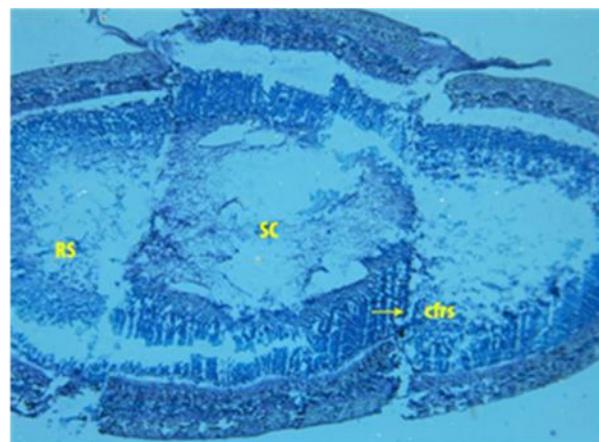
**Table 2.** Effect of different grafting methods and season of grafting on different growth and biochemical parameters of guava

Treatments	Leaf area (cm <sup>2</sup> ) (120 DAG)	Chlorophyll (SPAD unit) (120 DAG)	Photosynthetic rate (μmol CO <sub>2</sub> m <sup>-2</sup> s <sup>-1</sup> ) (120 DAG)	Total phenols (mg g <sup>-1</sup> ) (120 DAG)
<b>Method of grafting (G)</b>				
Approach grafting (G1)	39.07	24.25	15.26	3.52
Wedge grafting (G2)	41.83	24.32	16.11	3.24
Side grafting (G3)	39.08	23.66	14.23	3.95
S <sub>Ed</sub>	0.49	0.09	0.35	0.04
CD@5%	0.98	0.18	<b>0.70</b>	0.08
<b>Season of grafting (S)</b>				
Oct- Nov 2018 (S <sub>1</sub> )	40.90	23.96	15.23	3.64

Feb- March 2019 (S <sub>2</sub> )	37.34	24.10	14.94	3.54
June-July 2019 (S <sub>3</sub> )	41.74	24.18	15.42	3.52
S <sub>Ed</sub>	0.60	0.11	0.43	0.05
CD@5%	1.20	0.23	<b>0.86</b>	0.10
<b>Method of grafting x Season of grafting (SxG)</b>				
Approach grafting + Oct- Nov 2018 (G1S1)	39.42	24.22	15.14	3.57
Approach grafting + Feb- March 2019 (G1S2)	37.13	24.26	14.86	3.53
Approach grafting + June-July 2019 (G1S3)	40.67	24.29	15.78	3.44
Wedge grafting + Oct- Nov 2018 (G2S1)	42.40	24.25	16.11	3.28
Wedge grafting + Feb- March 2019 (G2S2)	39.04	24.30	15.96	3.27
Wedge grafting + June-July 2019 (G2S3)	44.04	24.40	16.26	3.16
Side grafting + Oct- Nov 2018 (G3S1)	40.87	23.39	14.45	4.09
Side grafting + Feb- March 2019 (G3S2)	35.86	23.73	14.01	3.80
Side grafting + June-July 2019 (G3S3)	40.50	23.85	14.23	3.95
S <sub>Ed</sub>	1.19	0.23	0.85	0.1
CD@5%	2.40	0.45	<b>1.72</b>	0.19



60<sup>th</sup> Days after grafting



90<sup>th</sup> Days after grafting

Fig. 1. Cross section of wedge graft union at 60<sup>th</sup> and 90<sup>th</sup> day after grafting

sc: scion

rs: rootstock

cc: callus cells

cfrs: complete fusion of rootstock and scion

pa: parenchyma cells

igup: improper graft union portion

REFERENCES

Anil, D.R. (2013). Studies on wedge grafting in guava (*Psidium guajava* L.) cv. Sardar. Doctoral

dissertation, Mahatma Phule Krishi Vidyapeeth, Rahuri.

[Google Scholar](#)

Anushma, P., Swamy, G.S.K. and Gangadhara, K. (2014). Effect of colored shade nets on softwood grafting success in jamun (*Syzygium cuminii* Skeels). *Plant Archives*. 14 (1):293-295.

[Google Scholar](#)

Bray, H.G. and Thrope, W.Y. (1954). Analysis of phenolic compounds of interests in metabolism. *Biochemical Analysis*. 112:52.

[Google Scholar](#)  
**Chakrabarty, U. and Sadhu, M.** (1989). Anatomy of graft union in epicotyl grafting of mango. *Acta Horticulture*. 231:182-185.

[Google Scholar](#)  
**Ding, C.K., Chachin, K., Hamauzu, Y., Ueda, Y. and Imahori, Y.** (1998). Effects of storage temperatures on physiology and quality of loquat fruit. *Postharvest Biology and Technology* 14 (3):309-315.

[Google Scholar](#)  
**Dolgun, O., Tekintas, F. and Ertan, E.** (2008). A Histological investigation on graft formation of some nectarine cultivars grafted on pixy rootstock. *World Journal of Agricultural Sciences* 4 (5):565-568.

[Google Scholar](#)  
**Johansen, D.A.** (1940). *Plant Micro technique*. McGraw-Hill Book Co., New York.

[Google Scholar](#)  
**Joshi, M., Syamal, M.M. and Singh, S.P.** (2014). Comparative efficacy of different propagation techniques in guava. *Indian Journal of Horticulture*., 71(3): 315-320.

[Google Scholar](#)  
**Kalalbandi, B., Ziauddin, S. and Shinde, B.** (2014). Effect of time of soft wood grafting on the success of sapota grafts in 50% shadenet under Marathwada conditions. *Agricultural Science Digest*. 34 (2).

[Google Scholar](#)  
**Kaundal, G.S., Gill, S.S. and Minhas, P.P.** (1987). Budding techniques in clonal propagation of guava (*Psidium guajava* L.). *Punjab Horticultural Journal*. 27: 208-211.

[Google Scholar](#)  
**Manna, A., Mathew, B. and Ghosh, S.N.** (2004). Air layering in guava cultivars. *Journal of Interacademia*, 5 (2), 278-281.

**Munthaj** (2014). Studies on improvement of seed germination and season of wedge grafting in guava (*Psidium guajava* L.). M.Sc Thesis. Horticultural College and Research Institute, Dr. Y.S.R. Horticultural University.

[Google Scholar](#)  
**Murti, G. and Upreti, K.** (2003). Endogenous hormones and phenols in rootstock seedlings of mango cultivars and their relationship with seedling vigour. *European Journal of Horticultural Science*:2-7.

[Google Scholar](#)  
**Rani, S.** (2010). Performance of vegetative propagation methods in guava under open and protected conditions. M.Sc. dissertation, CCS HAU, Hisar.

[Google Scholar](#)  
**Singh, G. and Pandey, D.** (1998). Effect of time and method of budding on propagation of guava (*Psidium guajava* L.). *Annals of Agricultural Research*. 19: 445-448.

[Google Scholar](#)  
**Singh, G., Singh, A.K. and Verma, A.** (2000). Economic evaluation of crop regulation treatments in guava (*Psidium guajava* L.). *Indian Journal of Agricultural Sciences*. 70: 226-230.

[Google Scholar](#)  
**Tiwari, R.K., Mistry, N.C., Singh, B. and Gandhi, C.P.** (2014). *Indian horticulture database 2013*. NHB, Ministry of Agriculture, Government of India, Gurgaon.

[Google Scholar](#)  
**Ulrich Schreiber, K. and Thomas, Klugel** (2003). Earth tide and tilt detection by a ring laser gyroscope. *Journal Of Geophysical Research*, 108 (B2): 2132.

[Google Scholar](#)