SEASONAL CHANGES IN SOIL RESPIRATION OF DEGRADED AND NON-DEGRADED SITES IN OAK AND PINE FORESTS OF CENTRAL HIMALAYA

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Abstract: Present investigation deals with the seasonal changes in soil respiration of degraded and non-degraded oak and pine forests in Van Panchayat of Kumaun Himalaya. Soil temperature and soil moisture enhances soil respiration by increasing microbial activity and decomposition of organic matter. The rate of soil respiration was higher in non-degraded site of oak forest in Dhaili VP (63.9±1.6 to 363.6±5.3 mg CO_2 $m^{-2}h^{-1}$), non-degraded site of pine forest (39.1±0.9 to 195.41.6 mg CO_2 $m^{-2}h^{-1}$) in Guna VP, and lower in degraded pine forest in Toli VP (21.3±0.5 to 126.8±0.8 mg CO_2 $m^{-2}h^{-1}$), degraded oak forest of Guna VP was (26.9±0.8 to 167.3±1.2 mg CO_2 $m^{-2}h^{-1}$). Within non-degraded and degraded sites of both oak and pine forests soil respiration was positively correlated with soil temperature and soil moisture.

Key words: Soil respiration; Degraded; Non-dedgraded; Van panchayat.

INTRODUCTION

Soil respiration is the primary path by which CO_2 fixed by land plants returns to the atmosphere. Soil respiration represents the sum total of all metabolic process in which CO_2 is produced. It includes the respiration of microorganism, soil animals and roots. In every ecosystem most of the organic matter added to the soil is in the form of litter, dead biomass, or root is processed through microbial and micro faunal activity, resulting in the production of CO_2 and the release of nutrients. Thus the rate of CO_2 released from soil is a major index of total metabolic activity (Joshi *et al*. 1991; Joshi and Rawat 2005).

The main objectives of the present investigation was to examine the differences in studying soil respiration rate between degraded and non-degraded sites of oak and pine forest and for determining the dependence of soil respiration on some selected edaphic condition and seasonal variations.

MATERIALS AND METHODS

The study sites are located in the Van Panchayats (VPs) of Dhaili, Toli, and Guna located in Lamgara block of Almora district in Uttaranchal. The Van Panchayats of Dhaili, Toli, and Guna are situated between 79° 41.4'-79° 43.2' E longitudes and 29° 32.9' -29° 34.3' latitudes with the elevation of 1800-2000m. Originally referred to as the crystalline zone of Almora by Heim and Gansser (1939) and commonly known "Almora crystallines", this vast over thrust succession of a variety of schists, micaceous quartizimeta morphism and with concordantly emplaced plutonic bodies of granodiorites and granites is renamed Almora group (Valdiya, 1980) after the township of Almora.

The selection criterion for degraded and non-degraded sites were presence and absence of regeneration, crown cover, number of lopped branches, fodder extraction and grazing. Climate of the area was referred to as monsoon warm temperate. The mean annual rainfall was 921.9 mm and mean monthly maximum temperature varied from 16.7 to 31.5 °C and minimum from 6.5 to 19.2 °C.

In the three main seasons winter was cold and dry (December to February), summer was warm and dry (April to mid June) and rainy was warm and humid (mid June to mid September). Severe frost is usual throughout the winters with frequent snowfall. Snow may last in shaded micro sites for a number of weeks.

Three soil samples from different locations in triplicate were collected randomly for each microsite from 0-30 cm soil depth and measured (Mishra, 1968).

CO_2 evolution was measured by alkali absorption method (Gupta and Singh, 1977) using aluminum cylinder (13 x 23 cm) inserted 10 cm into ground and 1:20 ratio of alkali absorption to soil area (Kirita, 1971). Three replicates of experimental cylinders were setup. Before each cylinder fixed, the green vegetation were totally removed falling inside the cylinder.

A 50 ml beaker containing 20 ml 0.5 NaOH (Gupta and Singh, 1977) was hung on a thin wire in each cylinder. The alkali was titrated against 1N HCl after 24 hour absorption period to avoid diurnal variation (Harris and Van Bavel, 1957). The cylinders were placed randomly and on each sampling date soil temperature was measured with a soil thermometer. Evolved CO_2 during experiment was calculated using given formula (Misra, 1968):

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Table 1: Soil respiration, temperature and moisture in the non-degraded and degraded sites of oak and pine forests.

Site name	Summer	Rainy	Winter
Soil respiration (mg CO_2 m^{-2} ha^{-1})			
Non-degraded oak sites			
Dhaili Van Panchayat	169.3±3.7	363.6±5.3	63.9±1.6
Guna Van Panchayat	172.2±4.1	350.1±4.9	62.5±1.4
Non-degraded pine sites			
Guna Van Panchayat	106.2±1.7	195.4±1.6	39.1±0.9
Toil Van Panchayat	100.5±1.8	189.5±2.4	35.4±1.0
Degraded oak sites			
Guna Van Panchayat	78.2±0.9	167.3±1.2	26.9±0.8
Dhaili Van Panchayat	81.6±1.2	171.1±1.1	29.5±0.6
Degraded pine sites			
Guna Van Panchayat	62.5±1.7	118.5±0.7	24.5±0.6
Toil Van Panchayat	70.8±1.3	126.8±0.8	21.3±0.5
Soil temperature (°C)			
Non-degraded oak sites			
Dhaili Van Panchayat	19.4±0.23	17±0.40	8.0±0.02
Guna Van Panchayat	19.6±0.40	16.5±0.52	7.9±0.03
Non-degraded pine sites			
Guna Van Panchayat	22.7±0.46	20.1±0.20	10.9±0.02
Toil Van Panchayat	23.1±0.23	20.1±0.23	11±0.01
Degraded oak sites			
Guna Van Panchayat	21.8±0.32	19.7±0.29	8.2±0.23
Dhaili Van Panchayat	19.5±0.17	17.5±0.20	9.3±0.23
Degraded pine sites			
Guna Van Panchayat	23.3±0.29	20.4±0.17	10.6±0.01
Toil Van Panchayat	21.67±0.44	19.8±0.46	9.7±0.29
Soil moisture (%)			
Non-degraded oak sites			
Dhaili Van Panchayat	27.7±0.37	50.5±1.04	33.57±1.16
Guna Van Panchayat	28.63±1.13	49.0±1.73	38.23±1.22
Non-degraded pine sites			
Guna Van Panchayat	25.2±0.91	46.1±1.48	39.1±0.80
Toil Van Panchayat	23.4±0.47	43.27±1.13	34.77±1.3
Degraded oak sites			
Guna Van Panchayat	16.43±0.47	36.67±1.09	28.57±0.74
Dhaili Van Panchayat	17.9±0.21	33.5±1.32	30.7±0.88
Degraded oak sites			
Guna Van Panchayat	22.31±0.71	34.5±0.76	27.23±0.39
Toil Van Panchayat	21.4±0.49	32.0±0.58	25.9±0.97

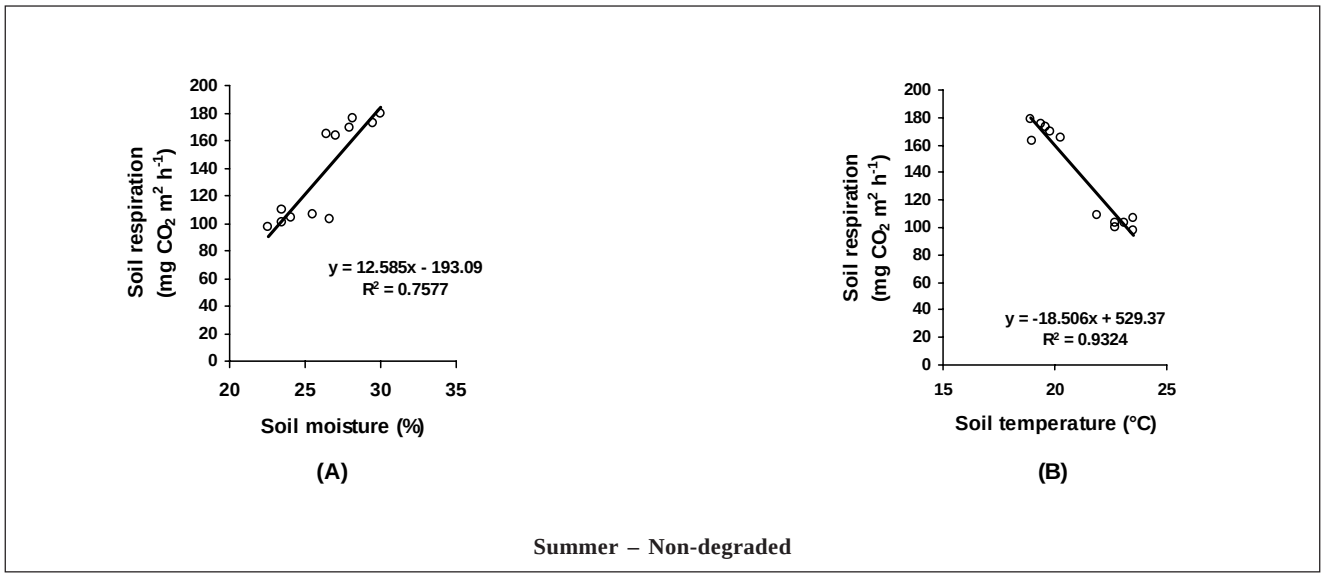
mg CO_2= V x N x 22

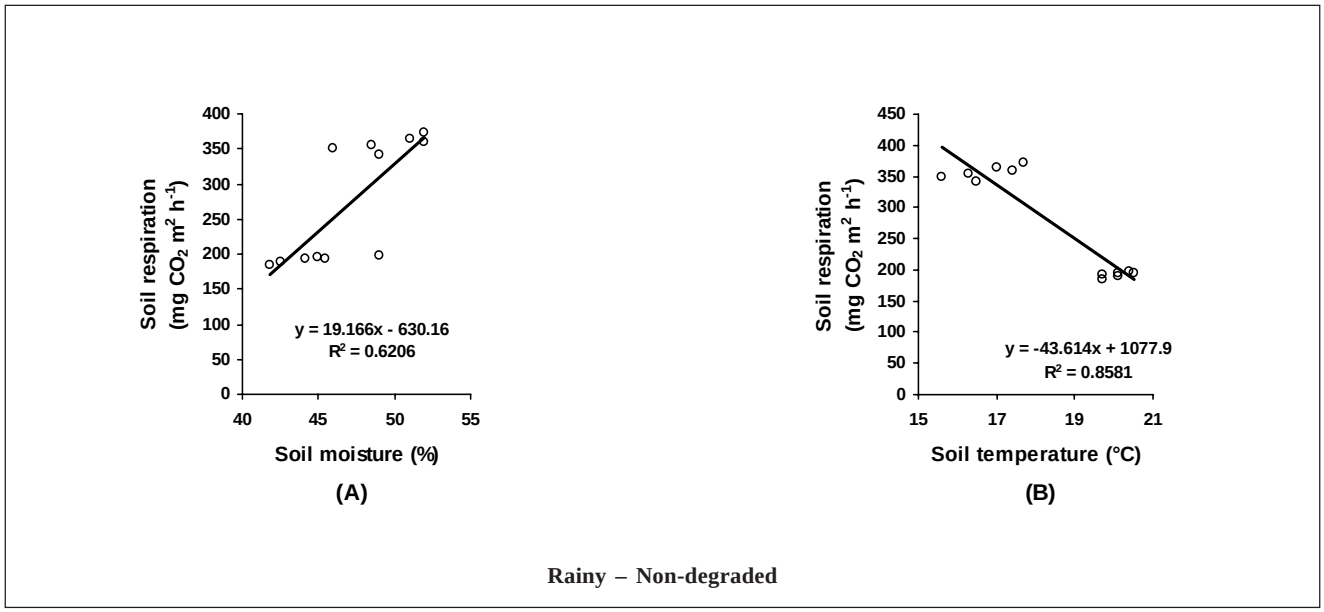
Where, V represents titration of blank minus sample titration and N is the normal acid value.

RESULTS

Seasonal pattern for total soil respiration (mg CO_2 m^{-2} h^{-1}) was identical in both non-degraded and degraded sites. Value was highest in rainy season (wet and warm) and lowest during winters (cold and moderately dry). Rainy season value was approximately twice the summer value at all sites, and three to five times higher than the winters (Table 1).

Regardless of season, rate of soil respiration was higher in non-degraded site of oak forest in Dhaili VP (63.9±1.6 to 363.6±5.3 mg CO_2 $m^{-2}h^{-1}$), non-degraded site of pine forest (39.1±0.9 to 195.41.6 mg CO_2 $m^{-2}h^{-1}$) in Guna VP, and lower in degraded pine forest in Toli VP (21.3±0.5 to 126.8±0.8 mg CO_2 m^{-2} h^{-1}), degraded oak forest of Guna VP was (26.9±0.8 to 167.3±1.2 mg CO_2 m^{-2} h^{-1}) (Table 1). Within non-degraded and degraded sites of both oak and pine forests soil respiration was positively correlated with soil temperature and soil moisture (Figure 1 and 2).





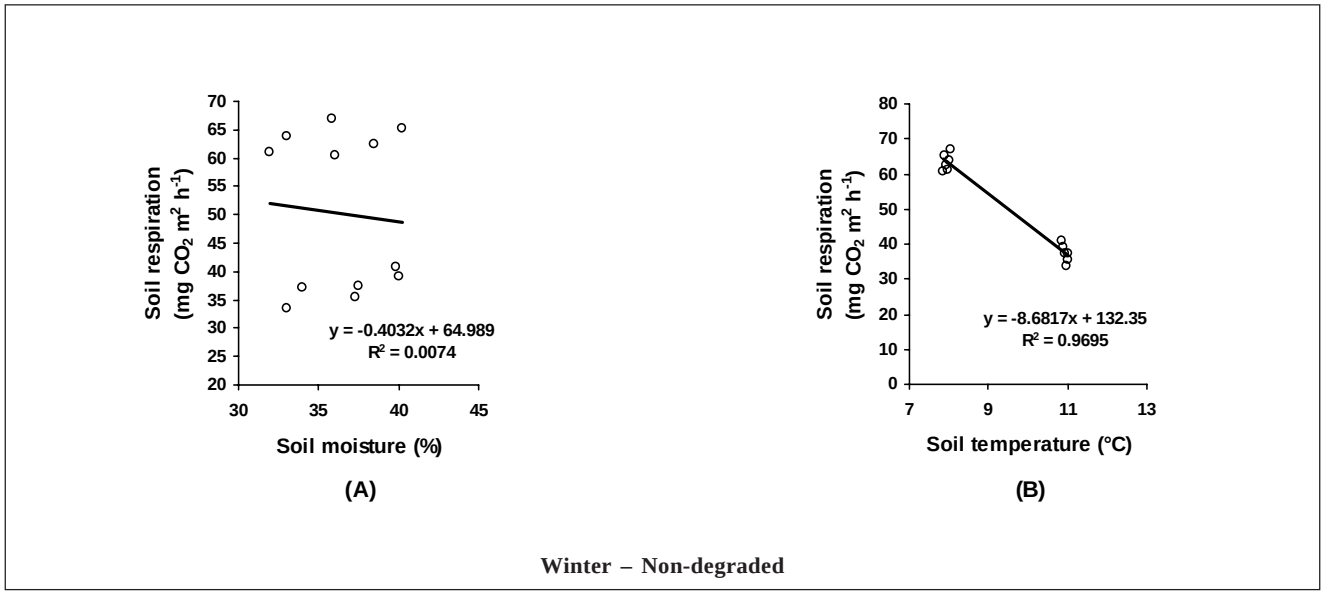
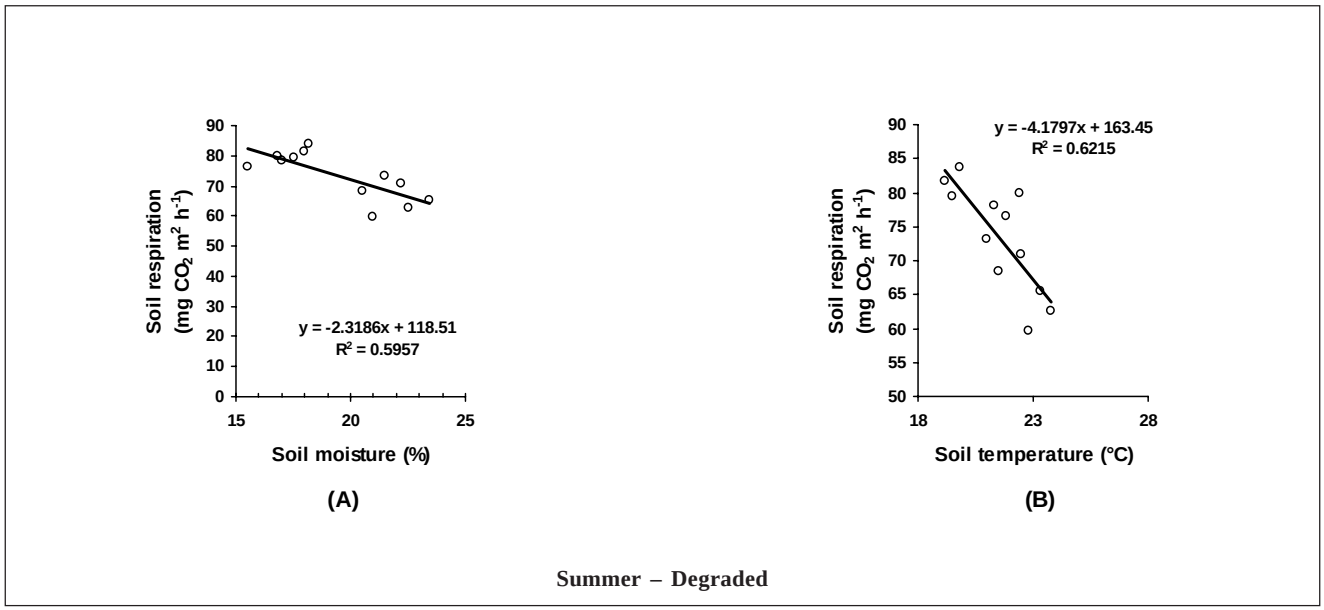
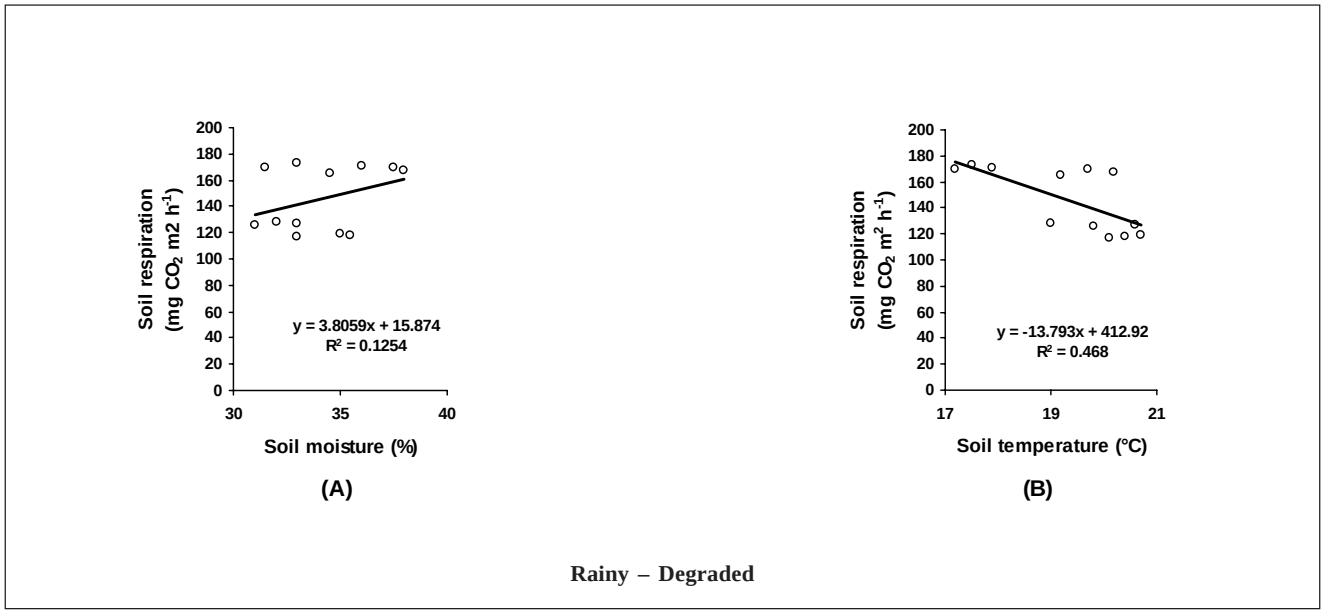


Fig. 1: Relationship between total soil respiration (mg CO_2 m^{-2} h^{-1}) with soil moisture and temperature in non-degraded sites of oak (A) and pine (B) forests.





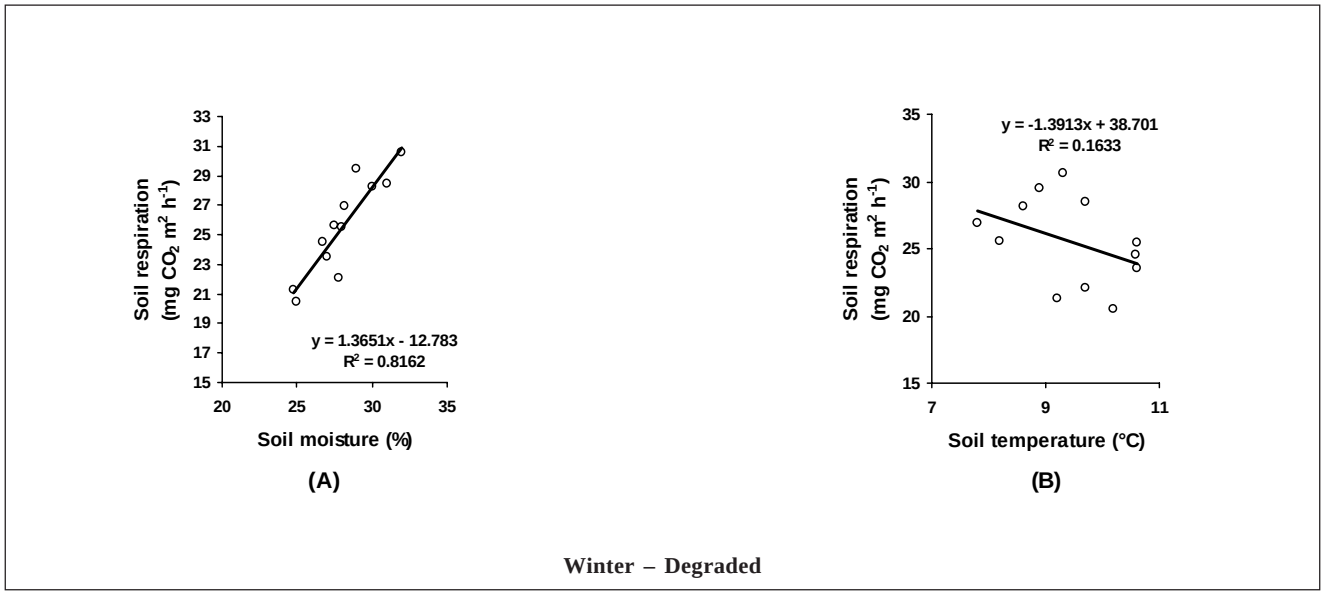


Fig. 2: Relationship between total soil respiration (mg CO_2 m^{-2} h^{-1}) with soil moisture and temperature in degraded sites of oak (A) and pine (B) forests.

DISCUSSION

In the present study values for total soil respiration were markedly higher in rainy season than during the others. CO_2 evolution from soil-litter system is governed directly or indirectly by two major environmental factors, i.e., temperature and moisture (Singh and Gupta, 1977) both of which were high during rainy season. Available soil moisture enhances soil respiration by increasing microbial activity and decomposition of organic matter (Witkamp, 1963; Anderson, 1973; Gupta and Singh, 1977). Seasonal variations in the physical environment were known to be wider in open sites than in forested sites (Larcher, 1980). This was clearly reflected in seasonal variations of total soil respiration. The total soil respiration values ranged from 206 to 333 mg CO_2 $m^{-2}h^{-1}$ during rainy season for central Himalayan oak and conifer forests (Tewari *et al.*, 1982). The soil respiration values of non-degraded and degraded sites of oak and pine forests of present study were in agreements with findings of other workers in temperate forest soils like Leith and Quellette (1962), Singh and Gupta (1977), Stubbing (1977), Weber (1985), Tewari *et al.* (1982), Joshi *et al*. (1991) and Joshi and Rawat (2005).

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