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RESEARCH PAPER

Linseed (*Linum usitatissimum* L.) sowing dates, genotypes influence on growth, yield attributes and yield

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Abstract : The experiment was laid out in Split Plot Design with three replications, with eighteen treatment combinations of date of sowing D_1 - 7th October (MW 40), D_2 - 14th October (MW 41), D_3 - 20th October (MW 42), D_4 - 25th October (MW 43), D_5 - 30th October (MW 44) and D_6 - 5th November (MW 45) as main plot treatments, and three cultivars (V_1 - Kiran, V_2 - Garima and V_3 - RLC-4) as sub plot treatments. The gross and net plot size of experimental unit was 6.4 m × 3.6 m and 5.4 m × 2.4 m, respectively with a row spacing of 30 cm and plant spacing as 10 cm. All recommended agronomical practices were adopted as per schedule. First date (D_1) and second date (D_2) crop sown in MW 40 and MW 41 recorded significantly higher leaf area index than other dates of sowing. The various growth characters like, plant height, spread of plant were higher in second (D_2) date than other dates of sowing. Mean number of branches per plant and dry matter accumulation was found significantly superior in first (D_1). D_1 which required less number of days for 50 per cent flowering and more days for maturity. The various yield attributing characters *viz.*, number of capsules plant^{-1}, weight of capsules plant^{-1}, number of seeds capsule^{-1}, seed weight plant^{-1} and thousand seed weight were found higher in first date of sowing. D_1 recorded significantly higher seed yield, straw yield, biological yield and harvest index than other treatments. The various growth characters *viz.*, number of branches plant^{-1}, spread of plant, total dry matter accumulation were substantially more in cv. GARIMA except plant height, which was recorded more in cv. RLC-4. Number of days required to 50 per cent flowering were also lesser in cv. GARIMA. The number of days required for physiological maturity were more in cv. KIRAN. Remarkably, the various yield attributes like mean number of capsule plant^{-1}, weight of capsules, mean number of seeds capsule^{-1}, seed weight plant^{-1}, weight of straw plant^{-1} and thousand seed weight were higher in cv. GARIMA over other cultivars. Among the cultivars, Garima recorded higher seed yield, straw yield, and biological yield as well at harvest index.

Key Words : Genotypes, Influence, Growth, Yield atributes

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INTRODUCTION

Linseed (*Linum usitatissimum* L.) is an important *Rabi* oilseed crop. It is grown under rainfed (63%), utera (20%) and irrigated (17%) conditions. It contains 35 to 47 per cent oil and 11 to 32 per cent protein. The oil extracted from linseed is mainly used in paint industries as a medium for oil paint, pad ink and printing ink etc.

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Table A : Details of biometric observations on linseed

Sr. No.	Particulars	Frequency	Days after sowing	Size of plant sample for each net plot
Pre-harvest studies				
1.	Plant count			
1.	Emergence count	1	21	All plants in each net plot
2.	Final plant count	1	At harvest	All plants in each net plot
Growth studies				
1.	Height of plant (cm)	7	30, 45, 60, 75, 90, 105 and at harvest	5 plants from each net plot
2.	Total number of branches			
3.	Dry matter plant^{-1} (g)	7	30, 45, 60, 75, 90, 105 and at harvest	1 plant from each net plot
4.	Days required for 50 per cent flowering	1	At flowering stage	5 plants from each net plot. Out of which three plants attained the stage.
Post harvest studies				
1.	No. of capsules pl^{-1}	1	At harvest	5 plants from each net plot
2.	Weight of capsules pl^{-1} (g)			
3.	No. of seeds / capsule			
4.	Weight of seeds pl^{-1} (g)			
5.	Thousand seed weight (Test weight)			
6.	Weight of straw pl^{-1} (g)			
7.	Seed yield / net plot (kg)	1	At harvest	From each net plot
8.	Seed yield / ha (kg)			
9.	Straw yield/plot (kg)			
10.	Straw yield / ha (kg)			

The oil is also used to some extent in the soap industries, pharmaceutical industries and other allied industries. In India the paint and allied industries is the major consumer of linseed accounting to 70 per cent of the total consumption.

MATERIAL AND METHODS

The data recorded were statistically analyzed by using technique of analysis of variance (Fisher, 1937) and significance was determined as given by Panse and Sukhatme (1967).

RESULTS AND DISCUSSION

The findings of the present study as well as relevant discussion have been presented under following heads :

Emergence count and final plant stand :

The data on mean emergence count was recorded on 20th date after each sowing date, whereas, final plant stand was recorded at the time of harvesting. The data recorded on mean emergence count and final plant stand per net plot, as influenced by different treatments are presented in Table 1. Data presented in Table 1 indicated that various treatments and their interaction effects did not influence the crop establishment significantly. Initial plant count was found non-significant in dates of sowing, cultivars and their interaction effects. Final plant stand was found significantly more in first (D_1) date of sowing at MW 40 than other date of sowing but it was at par with second (D_2) and third (D_3) date of sowing at MW 41 and MW 42. Cultivars and interaction effect was found non-significant.

Growth characters :

Plant height :

The data presented in Table 2 revealed that mean plant height of linseed was increased continuously from emergence upto 75 DAS and it was stabilized upto harvest of crop. Increase in plant height was slow upto 30 DAS and it was fast during 30 to 60 DAS. Later on, rate of increasing plant height was slow and stabilized after 75 DAS.

Date of sowing :

The data presented in Table 2 revealed that the mean

plant height was influenced significantly by different dates of sowing, at all stages of crop growth, except 45 DAS. The plant height was observed significantly more in second (D_2) than other dates of sowing, at all stages of crop growth except 75 DAS where third (D_3) date reported higher plant height but it was at par with second (D_2). Similar results are also observed by Sharma *et al.* (1995).

Cultivars :

Data presented in Table 2 reported that the mean plant height per plant was significantly influenced by different cultivars, at all stages of crop growth except 30 DAS and 45 DAS. Cultivar RLC-4 recorded significantly higher plant height than Kiran but it was at par with Garima, at all stages of crop growth, though the plant height was significantly higher in RLC-4.

Mean number of branches :

It is observed from Table 3 that mean number of branches per plant was increased continuously, upto harvest of crop.

Table 1 : Mean emergence count and final plant stand as influenced by different treatments

Treatments	Initial plant count	Final plant stand
Date of sowing		
D_1 (MW 40)	97	90
D_2 (MW 41)	96	89
D_3 (MW 42)	94	87
D_4 (MW 43)	93	85
D_5 (MW 44)	92	83
D_6 (MW 45)	91	81
S.E. ±	0.15	1.07
C.D. (P=0.05)	NS	3.4
Cultivars		
Kiran (V_1)	97	87
Garima (V_2)	96	86
RLC-4 (V_3)	95	85
S.E. ±	0.12	0.7
C.D. (P=0.05)	NS	NS

NS=Non-significant

Table 2 : Mean periodical plant height (cm) as influenced by different treatments

Treatments	Days after sowing						
	30	45	60	75	90	105	At harvest
Date of sowing							
D_1 (MW 40)	17.34	32.72	45.26	50.88	50.00	49.77	47.88
D_2 (MW 41)	19.62	33.22	49.95	53.00	53.66	52.11	50.22
D_3 (MW 42)	16.33	32.48	46.24	53.88	50.88	49.66	47.00
D_4 (MW 43)	16.25	31.80	45.22	47.00	46.44	45.77	45.11
D_5 (MW 44)	15.26	30.51	47.33	47.88	46.88	46.00	44.66
D_6 (MW 45)	14.64	31.13	39.66	41.22	41.11	41.00	40.11
S.E. ±	0.51	1.17	1.17	0.86	0.77	1.64	1.36
C.D. (P=0.05)	1.61	NS	3.7	2.73	2.43	5.19	4.29
Cultivars							
V_1 -Kiran	16.12	31.12	44.80	48.22	47.00	46.11	44.22
V_2- Garima	16.65	31.79	45.88	48.50	47.88	48.00	46.16
V_3- RLC-4	16.80	32.05	46.50	50.22	49.03	49.66	47.11
S.E. ±	0.27	0.5	0.50	0.44	0.61	0.57	0.56
C.D. (P=0.05)	NS	NS	1.48	1.29	1.79	1.67	1.64

NS=Non-significant

Date of sowing :

The data on mean number of branches plant^{-1} was influenced significantly by different dates of sowing, at all stages of crop growth. Mean number of branches was significantly more in first date (MW 40) than other treatments. Similar trends were also reported by Samui and Bandopadhyay (1991).

Cultivars :

The mean number of branches was influenced significantly by different cultivars, at all stages of crop growth except 45 and 60 DAS, cv. GARIMA produced more number of branches than RLC-4 and Kiran except at 45 and 60 DAS.

Spread of plant :

It was observed from Table 4 that the mean spread of plant was increased continuously from emergence upto 90 DAS of crop but later, it was decreasing upto harvest of crop.

Date of sowing :

The data presented in Table 4 indicated that mean spread of plant (cm) was influenced significantly by

Table 3 : Mean periodical number of branches plant^{-1} as influenced by different treatments

Treatments	Days after sowing						
	30	45	60	75	90	105	At harvest
Date of sowing							
D_1 (MW 40)	4.2	6.5	6.6	6.7	6.9	7.1	7.2
D_2 (MW 41)	3.7	5.6	6.1	6.3	6.5	6.9	7.0
D_3 (MW 42)	3.2	5.1	5.1	5.9	6.3	6.5	6.6
D_4 (MW 43)	3.7	4.3	4.5	4.9	5.1	5.2	5.3
D_5 (MW 44)	3.0	5.0	5.6	5.7	5.9	5.9	6.0
D_6 (MW 45)	3.0	4.5	4.6	4.8	5.3	5.4	5.4
S.E. ±	0.06	0.12	0.12	0.10	0.09	0.13	0.13
C.D. (P=0.05)	0.19	0.39	0.39	0.33	0.30	0.42	0.41
Cultivars							
V_1 -Kiran	3.3	5.0	5.3	5.5	5.8	6.0	6.1
V_2- Garima	3.3	5.2	5.7	6.1	6.3	6.5	6.6
V_3- RLC-4	3.2	5.3	5.3	5.4	5.9	6.1	6.2
S.E. ±	0.05	0.13	0.09	0.09	0.09	0.09	0.08
C.D. (P=0.05)	NS	NS	NS	0.27	0.27	0.26	0.23

NS=Non-significant

Table 4 : Mean periodical spread of plant (cm) as influenced by different treatments

Treatments	Days after sowing					
	45	60	75	90	105	At harvest
Date of sowing						
D_1 (MW 40)	8.1	10.7	11.3	14.6	9.7	8.0
D_2 (MW 41)	9.8	11.9	16.0	15.0	12.7	11.6
D_3 (MW 42)	9.7	10.5	15.2	14.6	12.6	11.2
D_4 (MW 43)	8.7	9.8	12.2	12.1	10.1	8.2
D_5 (MW 44)	6.7	8.5	10.2	10.4	11.2	8.8
D_6 (MW 45)	7.1	7.8	10.1	9.7	6.7	5.7
S.E. ±	0.24	0.22	0.16	0.17	0.20	0.17
C.D. (P=0.05)	0.76	0.69	0.51	0.56	0.64	0.54
Cultivars						
V_1 -Kiran	7.9	9.6	11.9	11.7	9.7	8.1
V_2- Garima	9.0	10.2	13.0	13.5	11.4	9.5
V_3- RLC-4	8.3	9.7	12.6	13.0	10.3	9.0
S.E. ±	0.13	0.15	0.13	0.10	0.10	0.10
C.D. (P=0.05)	0.38	0.44	0.38	0.31	0.31	0.30

different time of sowing, at all stages of crop growth. Second (D_2) date of sowing at MW 41 was found to have significantly highest spread of plant, at all stages of crop growth.

Cultivars :

The data presented in Table 4 indicated that the mean spread of plant (cm) was influenced significantly by different cultivars, at all the stages of crop growth. The cv. GARIMA recorded significantly higher spread of plant than RLC-4 and Kiran at all the stages of crop growth.

Dry matter accumulation :

The data presented in Table 5 indicated that the dry matter accumulation plant^{-1} was increased continuously from emergence to harvest of crop. The rate of increasing dry matter accumulation was slow upto 60 DAS and it was remarkably fast between 60-75 DAS.

Date of sowing :

The data presented in Table 5 revealed that the mean total dry matter (g plant^{-1}) was influenced significantly due to different time of sowing as the crop growth advanced. The data presented in Table 5 revealed that

Table 5 : Mean periodical dry matter accumulation plant^{-1} (g) as influenced by various treatments

Treatments	Days after sowing						
	30	45	60	75	90	105	At harvest
Date of sowing							
D_1 (MW 40)	0.48	1.2	2.3	5.1	5.3	2.4	2.3
D_2 (MW 41)	0.26	0.9	1.4	4.3	4.3	2.1	2.0
D_3 (MW 42)	0.25	1.2	1.4	2.4	2.7	2.2	2.1
D_4 (MW 43)	0.41	0.7	1.2	2.7	2.5	1.8	1.7
D_5 (MW 44)	0.35	0.7	2.0	2.6	2.7	1.4	1.3
D_6 (MW 45)	0.05	0.5	0.9	1.2	1.5	1.0	1.0
S.E. ±	0.06	0.02	0.02	0.21	0.18	0.03	0.05
C.D. (P=0.05)	0.021	0.08	0.08	0.38	0.32	0.09	0.8
Cultivars							
V_1 -Kiran	0.19	0.18	1.5	2.6	2.8	1.8	1.7
V_2- Garima	0.21	0.9	1.7	3.2	3.5	1.9	2.0
V_3- RLC-4	0.20	0.9	1.6	2.6	2.9	1.8	1.8
S.E. ±	0.005	0.02	0.04	0.06	0.02	0.26	0.043
C.D. (P=0.05)	0.015	0.06	0.08	0.19	0.06	0.08	0.12

Table 6 : Mean number of days required for 50 per cent flowering and days to maturity as influenced by various treatments

Treatments	Days to 50 per cent flowering	Days to maturity
Date of sowing		
D_1 (MW 40)	57	116
D_2 (MW 41)	60	115
D_3 (MW 42)	62	113
D_4 (MW 43)	63	112
D_5 (MW 44)	67	111
D_6 (MW 45)	69	110
S.E. ±	0.23	0.29
C.D. (P=0.05)	0.74	0.93
Cultivars		
V_1 -Kiran	66	118
V_2- Garima	64	112
V_3- RLC-4	60	108
S.E. ±	0.22	0.16
C.D. (P=0.05)	0.66	0.49

mean dry matter plant^{-1} was significantly higher at first date (MW 40) than other treatments of sowing time. Similar results were also reported by Samui and Bandopadhyay (1991).

Cultivars :

The effect of cultivars on dry matter plant^{-1} is presented in Table 5. The data reported that total dry matter accumulation plant^{-1} was significantly higher in cv. GARIMA over other cultivars but it was at par with Kiran, through out the crop period.

Number of days required for 50 per cent flowering :

The data on number of days required for 50 per cent flowering, as influenced by different treatments are presented in Table 6.

Date of sowing :

The data on mean number of days required for 50 per cent flowering was influenced significantly by different dates of sowing. The first date of sowing required significantly less number of days to 50 per cent flowering than other date of sowing. The data further revealed that as the sowing was delayed, the duration required for 50 per cent flowering was increasing.

Cultivars :

The data on mean number of days required for 50 per cent flowering was influenced significantly by different cultivars. The cv. RLC-4 which produced significantly lower yield, required significantly less number of days for 50 per cent flowering than Garima and Kiran.

Number of days required for maturity :

The data regarding mean numbers of days required for maturity of linseed crop as influenced by different treatments are presented in Table 6.

Date of sowing :

The data on mean number of days required for maturity was influenced significantly by different dates of sowing. The first (D_1) date of sowing at MW 40 required significantly more time to mature than other sowing time treatments. The duration to attain physiological maturity reported a decreasing trend, as the sowing was delayed.

Cultivars :

The data on mean number of days required for maturity was influenced significantly by different cultivars, cv. RLC-4 required lesser days for maturity than Garima (112) and Kiran (118), which in turn, resulted in lowest seed yield.

Post harvest studies :

The data regarding yield attributing characters *viz.*, mean number of capsules plant^{-1}, weight of capsules plant^{-1}, number of seeds capsule^{-1}, weight of seeds

Table 7 : Mean number of capsules plant^{-1}, weight of capsules plant^{-1}, number of seeds capsule^{-1}, weight of seeds plant^{-1}, weight of straw plant^{-1} and thousand seed weight as influenced by various treatments

Treatments	Number of capsules plant^{-1}	Weight of capsules plant^{-1}	Number of seeds capsule^{-1}	Weight of seeds plant^{-1} (g)	Weight of straw plant^{-1} (g)	Thou-sand seed weight (g)
Date of sowing						
D_1 (MW 40)	42	2.6	9.0	2.1	2.8	7.6
D_2 (MW 41)	41	2.5	7.9	1.9	4.1	7.2
D_3 (MW 42)	38	1.9	8.3	1.6	3.8	7.1
D_4 (MW 43)	27	1.3	7.4	0.9	2.9	7.1
D_5 (MW 44)	23	1.2	7.6	0.9	2.6	7.1
D_6 (MW 45)	11	0.5	4.6	0.3	1.7	7.1
S.E. ±	0.46	0.05	0.10	0.03	0.08	0.07
C.D. (P=0.05)	1.46	0.18	0.31	0.09	0.27	0.23
Cultivars						
V_1 -Kiran	27	1.4	7.3	0.9	2.6	7.2
V_2- Garima	33	1.8	7.9	1.7	3.4	7.1
V_3- RLC-4	31	1.7	7.2	1.1	2.9	7.2
S.E. ±	0.31	0.02	0.08	0.02	0.05	0.03
C.D. (P=0.05)	0.91	0.05	0.24	0.06	0.15	NS

NS=Non-significant

plant^{-1}, weight of straw plant^{-1} and thousand seed weight are presented in Table 7.

Number of capsules plant^{-1} :

The data presented in Table 7 revealed that mean number of capsules plant^{-1} was influenced significantly by different treatments.

Date of sowing :

The effect of date of sowing on mean number of capsules plant^{-1} shows that first (D_1) date of sowing at MW 40 recorded significantly more number of capsules plant^{-1} than other date of sowing but it was at par with second (D_2) date of sowing at MW 41. These two treatments ranked first and second in respect of number of capsules palnt^{-1}. Similar trend was also observed by Singh (1968); Dixit *et al*. (1994) and Verma and Pathak (1993).

Cultivars :

The effect of different cultivars on mean number of capsules plant^{-1} shows that cv. GARIMA was significantly superior over other cultivars, which has produced significantly highest number of capsuler per plant.

Weight of capsules plant^{-1} (g) :

The data presented in Table 7 revealed that weight of capsules plant^{-1} was influenced significantly by different time of sowing and cultivars.

Date of sowing :

The study of effect of different date of sowing on mean weight of capsules plant^{-1} (g) noted that first date (MW 40) recorded significantly higher weight of capsules plant^{-1} than other dates of sowing but it was at par with second date (MW 41).

Cultivars :

The effect of cultivars on mean weight of capsules plant^{-1} revealed that cv. GARIMA recorded significantly highest capsule weight plant^{-1} over other cultivars.

Number of seeds capsule^{-1} :

The data presented in Table 7 revealed that mean number of seeds capsule^{-1} was influenced significantly by different treatments.

Date of sowing :

The effect of different dates of sowing on mean number of seeds capsule^{-1} reported that treatment D_1 at MW 40 recorded significantly more number of seeds capsule^{-1}, however, it was at par with treatment D_2. Treatment D_6 produced lowest number of seed capsule^{-1}. Above results are in conformity with Verma and Pathak (1993).

Cultivars :

The effect of different cultivars on mean number of seed capsule^{-1} indicated that cv. GARIMA was significantly superior over other cultivars. However, cv.

Table 8 : Mean seed yield (kg ha^{-1}), straw yield (kg ha^{-1}), total biomass (kg ha^{-1}), as influenced by various treatments

Treatments	Seed yield (kg/ha)	Straw yield (kg/ha)	Total biomass (kg/ha)
Date of sowing			
D_1 (MW 40)	889	2109	2998
D_2 (MW 41)	823	2999	2822
D_3 (MW 42)	654	1999	2653
D_4 (MW 43)	543	1540	2083
D_5 (MW 44)	473	1582	2055
D_6 (MW 45)	334	979	1313
S.E. ±	7.33	10.48	12.43
C.D. (P=0.05)	23.12	33.05	39.19
Cultivars			
V_1 –Kiran	613	1619	2232
V_2- Garima	656	1773	2429
V_3- RLC-4	588	1712	2300
S.E. ±	6.4	6.8	6.5
C.D. (P=0.05)	19.0	19.92	19.02

KIRAN and RLC-4 were at par with each other.

Seed weight plant^{-1} (g) :

Data presented in Table 7 revealed that the mean seed weight plant^{-1} was influenced significantly by different treatments.

Date of sowing :

The weight of seeds plant^{-1} at first date (MW 40) was found significantly superior over other dates. Treatments D_6 produced lowest seed weight plant^{-1}.

Cultivars :

The effect of different cultivars on seed weight plant^{-1} indicated that cv. GARIMA was significantly superior over other cultivars.

Weight of straw plant^{-1} (g) :

The data presented in Table 7 revealed that the mean weight of straw plant^{-1} was significantly influenced by dates of sowing and cultivars.

Dates of sowing :

The mean weight of straw plant^{-1} was significantly highest in second (D_2) dates of sowing at MW 41 than other dates of sowing.

Cultivars :

The effect of different cultivars on weight of straw plant^{-1} indicated that cv. GARIMA recorded significantly highest weight of straw plant^{-1} than other cultivars.

Thousand seed weight :

The data presented in Table 7 revealed that the mean thousand seed weight was found non-significant due to cultivars.

Date of sowing :

The effect of different date of sowing on thousand seed weight (g) was found to be significant. First (D_1) date of sowing recorded significantly more thousand seed weight than other date of sowing at MW 40. Similar results were also observed by Verma and Pathak (1993).

Cultivars :

The effect of different cultivars on thousand seed weight (g) was found non-significant.

Yield :

The data regarding yield *viz.*, seed yield, straw yield, and total biomass are presented in Table 8.

Seed yield (kg ha^{-1}) :

The data presented in Table 8 revealed that mean seed yield (kg ha^{-1}) was influenced significantly by various dates of sowing and cultivars.

Date of sowing :

The mean seed yield (kg $^{-1}$ha) was found significantly higher in first (D_1) at MW 40 over other date of sowing treatments and was significantly superior. Similar trends were also recorded by Verma and Pathak (1993); Sharma *et al*. (1995) and Sharma and Roy (1987).

Cultivars :

The effect of cultivars on seed yield ha^{-1} revealed that cv. GARIMA produced significantly higher seed yield than other cultivars. Similar findings were also reported by Verma and Pathak (1993); Dubey and Srivastava (1986).

Straw yield :

Data presented in Table 8 revealed that the mean straw yield of linseed was influenced significantly by different treatment.

Date of sowing :

The data presented in Table 8 revealed that first (D_1) date of sowing at MW 40 gave highest yield of 2999 kg ha^{-1} and was significantly superior than other date of sowing treatments. The second and third highest position in respect of grain yield of linseed was acquired by D_2 and D_3 treatment at MW 41 and MW 42. Above results are in confirmation with Tomar and Mishra (1989) and Dixit *et al.* (1994). The significantly lowest grain yield of linseed was acquired by D_6 treatment at MW 45.

Cultivars :

The effect of cultivars on straw yield ha^{-1} presented in Table 8 revealed that cv. GARIMA gave significantly higher straw yield than other cultivars.

Biological yield (kg ha^{-1}) :

The data presented in Table 8 revealed that mean biological yield was influenced significantly by different treatments.

Date of sowing :

The data presented in Table 8 revealed that biological yield was found significantly more in first (D_1) date of sowing at MW 40 than other dates of sowing. The similar findings have been reported by researchers Dixit *et al.* (1994).

Cultivars :

The effect of cultivars on biological yield ha^{-1} revealed that cv. GARIMA was significantly superior than other cultivars.

Conclusion :

- The cv. GARIMA proved to be superior in recording more seed yield as compared to other cultivars.
- Sowing of linseed cv. GARIMA with first date of sowing MW 40 was found advantageous in recording more seed yield.
- On the basis of above conclusion it can be indicated that the linseed cv. GARIMA be sown with date (40 MW) for higher yield under Marathwada condition.

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