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Assessment of seed quality and vigour in fifty genotypes of fennel (*Foeniculum vulgare* Mill.)

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Abstract
A study was conducted in the lab of department of seed science and technology, CCS Haryana Agricultural University, Hisar during the years 2015-16 and 2016-17 with fifty genotypes of fennel to assess the seed quality and vigour. Fifty genotypes of fennel seeds were collected from different locations of India (Haryana, Rajasthan, Gujarat, Uttar Pradesh and Bihar). Significantly highest standard germination (%) (93.00%), seedling length (cm) (23.59 cm), dry weights of 10 seedlings (10.96 mg), vigour index - I (2194) and vigour index - II (1018) were apparent in genotype HF – 171. The results showed significant variability among the fifty genotypes of fennel and HF-171, HF-173, HF-169 and HF-168 found superior in terms of seed quality and vigour parameters. Hence these genotypes can be used as breeding material for further breeding purposes.

Keywords: Fennel, seed quality, standard germination, seedling length and vigour

Introduction
Fennel is growing in the states of Gujarat, Rajasthan and Haryana and to some extent in other states as one of the most important winter season spices. Fennel is an open pollinated spice crop belongs to the family Umbelliferae (Apiaceae), has originated from Mediterranean region, where its high degree of genetic variability persists (Miranldi, 1999) [10]. In India fennel is cultivated covering a total area of about 0.91 lakh hectares and yearly production of 1.53 lakh MT with productivity of 1.7 MT per hectares (Anon., 2017). Fennel seed consists of 6.3% moisture, 9.5% protein, 10% fat, 13.4% minerals, 18.5% fibre and 42.3% carbohydrates and also vitamins like vitamin C, thiamin, riboflavin, niacin and minerals like calcium, phosphorous, iron, sodium and potassium (Bhunia *et al*., 2005) [4]. Fennel seeds are used for mastication and chewing either alone or with betel leaves (Girija, 1952) [6].
The quality seed is essential to enhance the production and productivity (Sidhawani, 1991) [15]. It has been demonstrated to realize that use of quality seeds highest productivity of crop by 15-20 percent. International Seed Testing Association (ISTA, 1999) [8] has proposed a numerous tests which have been developed to evaluate seed vigour but appropriate procedures for choosing the best single (or) multiple predictors of seed performance are necessary. Since, a little information is available for seed vigour assessment on fennel; hence other crops have also been reported. (Mor *et al*., 2009; Pramila *et al*., 2013) [11, 13].

Materials and Methods
The present experiment "Assessment of Seed Quality and Vigour in Fifty Genotypes of Fennel (*Foeniculum vulgare* Mill.)'' was carried out during 2015-16 and 2016-17 at CCS Haryana Agricultural University, Hisar (Haryana). The seeds collected from different locations of India (Haryana, Rajasthan, Gujarat, Uttar Pradesh and Bihar) were sown on 14th November, 2015 for first year and on 12th November, 2016 for second year. The plot size was 3.0 m x 1.0 m with spacing of 50 cm x 20 cm. Seed harvesting (23rd May, 2016 for first year and 26th May, 2017 for second year) was done after full maturity and seeds were sun dried for 4 to 5 days in the field. All the recommended agronomic practices were followed timely for successful raising the crop. The statistical design adopted for this study was randomized block design and the treatments replicated thrice.
After proper drying, cleaning and attaining the optimum moisture content the seeds were collected and shifted to laboratory to study the seed quality parameters viz., seed germination percentage, seedling length, seedling dry weight, seed vigour Index I and II. This study was designed in completely randomized design with three replications.

Standard germination (%): It was determined by selecting 100 seeds from the each selected genotype following the Between Paper method (BP). In this method the seeds were placed separately between two layers of moist germination paper and then kept in seed germinator at 25 ^{0}C. The final count of normal seedlings were recorded on the 14th day and expressed as percent germination.

Seedling length (cm): The seedling length was recorded by measuring the ten randomly selected normal seedlings from the standard germination test and it was expressed in centimeters.

Seedling dry weight (mg): The seedling dry weight was recorded by weighing the ten randomly selected normal seedlings that were used in seedling length measurement. In this test, the selected seedlings were dried at 80 ^{0}C for 48 hrs and then dry weight was recorded in milligram.

Seed vigour indices: For measuring seed vigour**,** the formulae suggested by Abdul Baki and Anderson, 1973 was followed.

Seed Vigour index-I: Standard germination (%) x Average seedling length (cm)

Seed vigour index- II: Standard germination (%) x Average seedling dry weight (mg)

Results and Discussion

The data depicted in Table 1 illustrates that mean sum of squares due to fennel genotypes was highly significant for all the parameters, which indicated the presence of considerable and significant amount of variability among the genotypes for all vigour parameters. The differences in the seed viability and vigour are a function of complex interaction of genetic constitution, environmental, nutrition or mother plant, maturity at harvest, seed weight and size, mechanical integrity and ageing factors. The variability results in wheat crop revealed that seed vigour parameters are strongly under genetic control which is due to highest heritability of character accompanied with genetic advance (Wani *et al.*, 2013) [18]. James (1967) [9] also reported that variation for seed longevity and vigour among genotypes can be controlled genetically.

The data on standard germination (%) demonstrated that significant variations were apparent in all the genotypes (Fig. 1). The genotype HF – 171 registered maximum standard germination percentage (93.00%) followed by HF-173 (90.83%), HF-169 (90.33%), HF-175 (90.17%), HF-168 (90.00%) and HF- 167 (89.83%). The highest germination percentage in these genotypes could be due to characters like large seed size, high test weight and more density (Pereira *et al.*, 2008) [12]. In addition to these parameters, high α-amylase activity, fully matured embryo and high amounts of food reserves present in these genotypes might have improved the germination percent in comparison to other genotypes (Ioana *et al*., 2015; Bailly, 2004) [7, 3]. In another work, Rubim *et al.* (2013) [14] had recorded that influence of packaging types and storage conditions on physiological quality of fennel seeds. This study results were in agreement with the Deswal *et al.* (2017) [5] who observed significant variation among the sixty genotypes of the fennel.

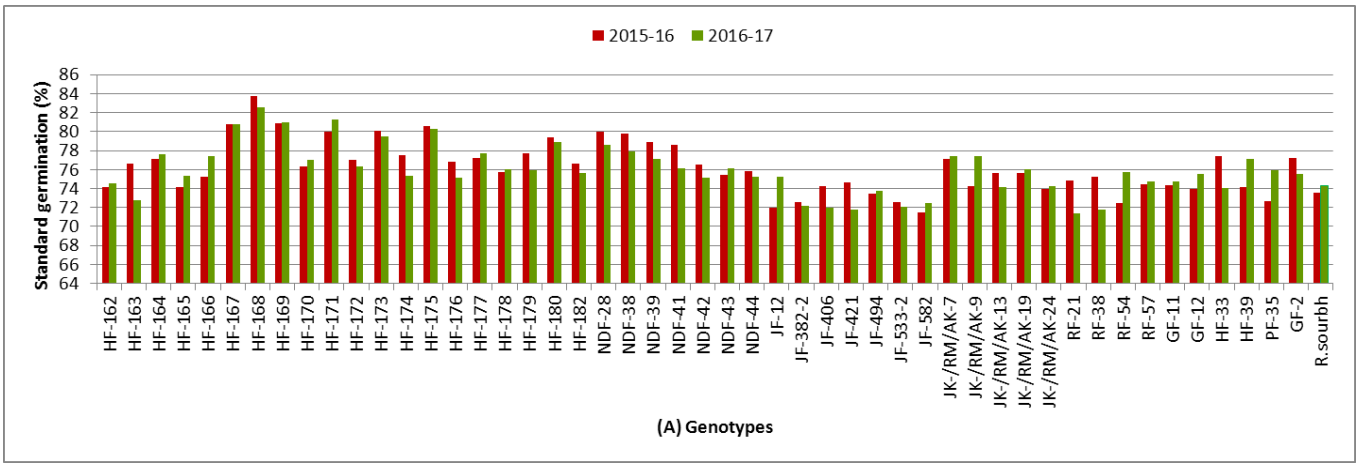
Highest seedling length (23.59 cm) was registered in genotype HF-171, which was on par with five other genotypes (HF-169, HF-168, HF-173, HF-167 and HF-175). The genotype HF – 171 recorded highest seedling dry weight (10.96 mg) which was on par with HF-168 (9.75) (Fig. 1 and 2). These observations are in agreement with Soltani *et al.*, 2002 [16] who claimed that genotypes with more test weight and seed size have higher seedling length and dry weight in chickpea.

Significant variations were recorded in all the genotypes with respect to seed vigour index-I and II (Fig.4 and Fig.5). The seeds extracted from genotype HF-171 implicated in registering highest vigour index-I (2194) followed by HF-169 (2074), which was on par with HF- 173 (2067), HF-168(2064), and HF-167 (2033). Similarly, seed vigour index-II was maximum in HF-171 (1018) followed by HF-168 (908), HF-169 (880), HF-173 (866) and HF-167 (820). These results are in line with Sonmez, 2000 who reported that dry weight of the seedlings of barley showed a positive response to water and nutritional uptake. A study conducted by Pramila *et al.* (2013) [13] revealed that physical purity, seed germination and seedling vigour index were high in fenugreek seed lots, followed by fennel and coriander.

Table 1: Analysis of variance for different seed quality and vigour assessment parameters in 50 genotypes of fennel

Sr. No.	Source / Parameters	Variety (MSS)	Error	CV (%)
1	Standard germination	22.27**	1.24	1.29
2	Seedling length	4.73**	0.54	3.48
3	Seedling dry weight	2.62**	0.06	3.09
4	Vigour index-I	76292.35**	4875.90	3.85
5	Vigour index-II	30368.30**	447.18	3.14

** Significant at 1%



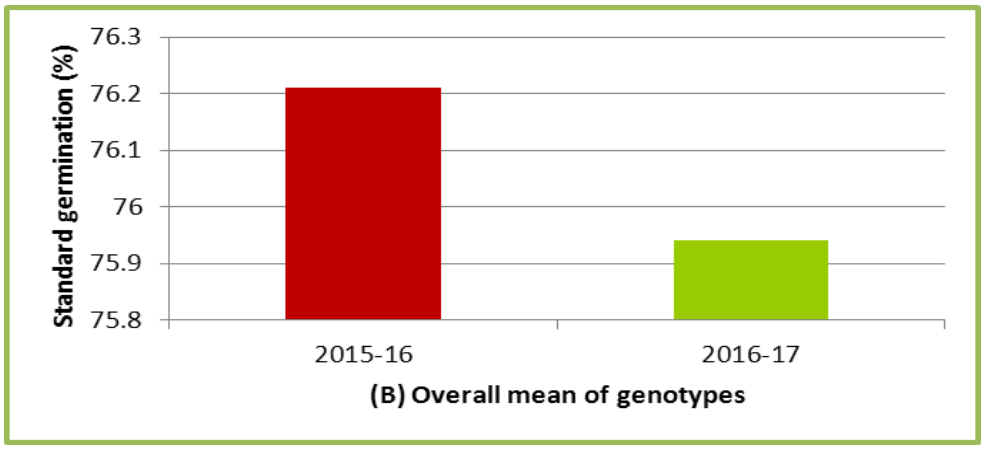
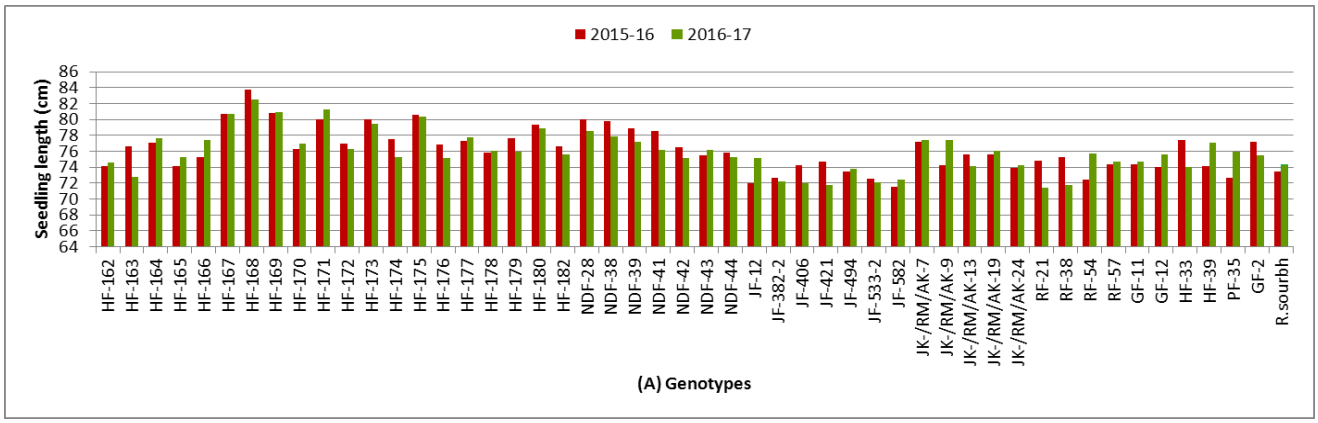


Fig 1: Standard germination percentage of genotypes (A) and overall mean of genotypes (B)



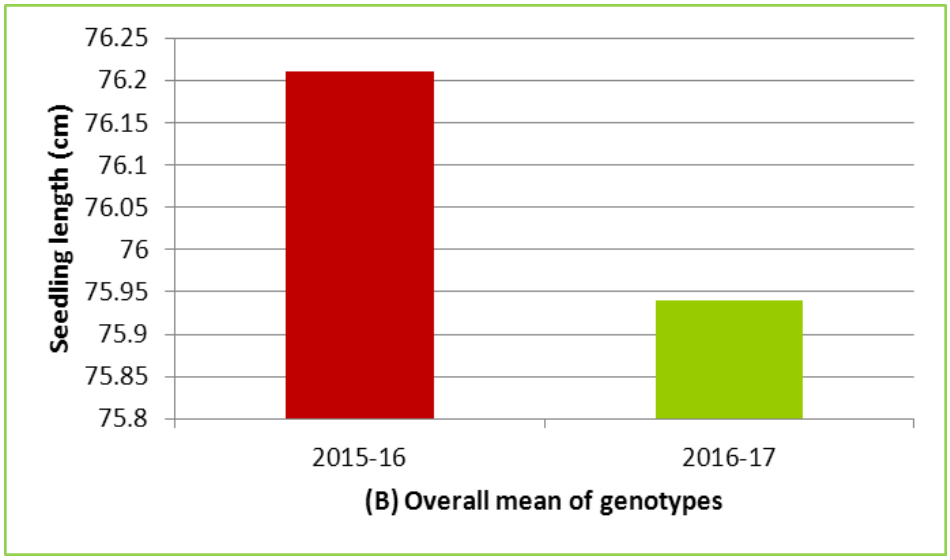
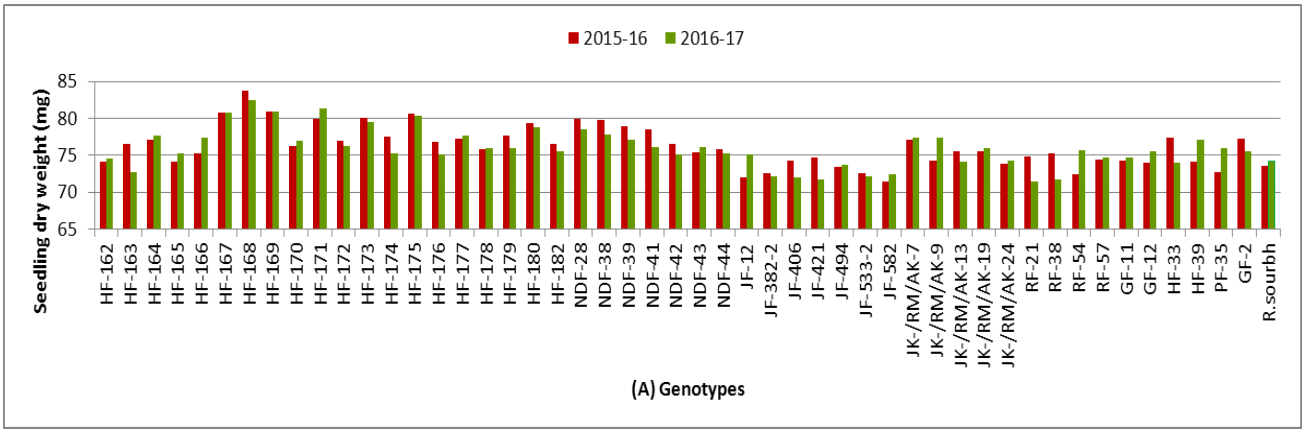


Fig 2: Seedling length (cm) of genotypes (A) and overall mean of genotypes (B)



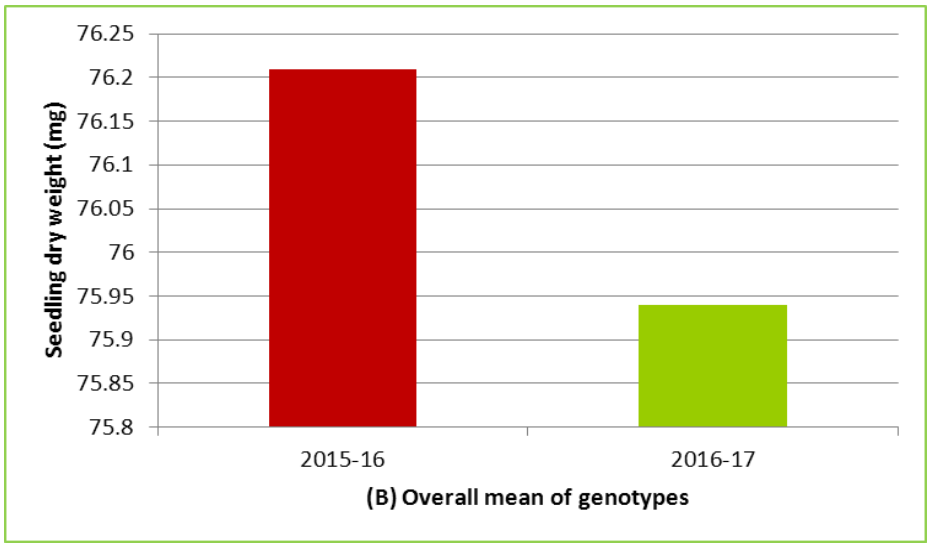
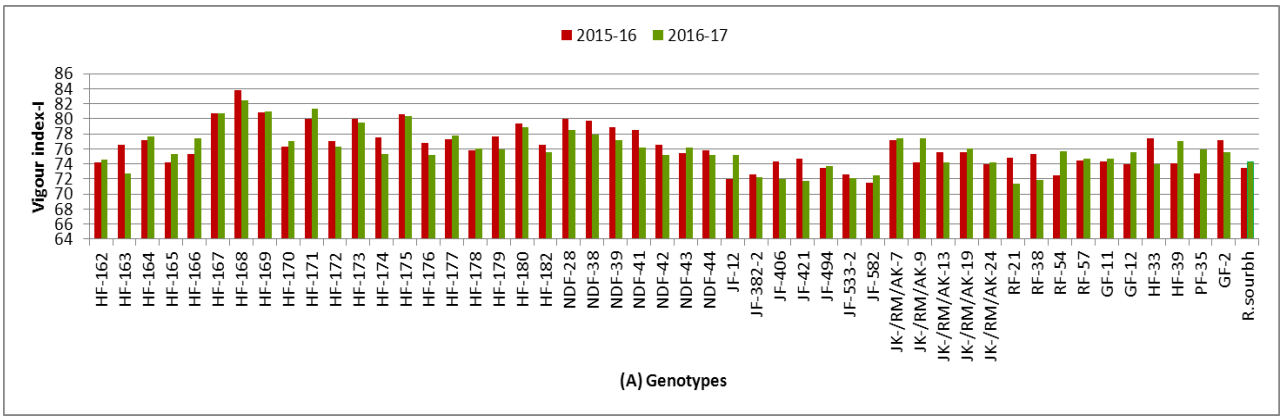


Fig 3: Seeding dry weight (mg) of genotypes (A) and overall mean of genotypes (B)



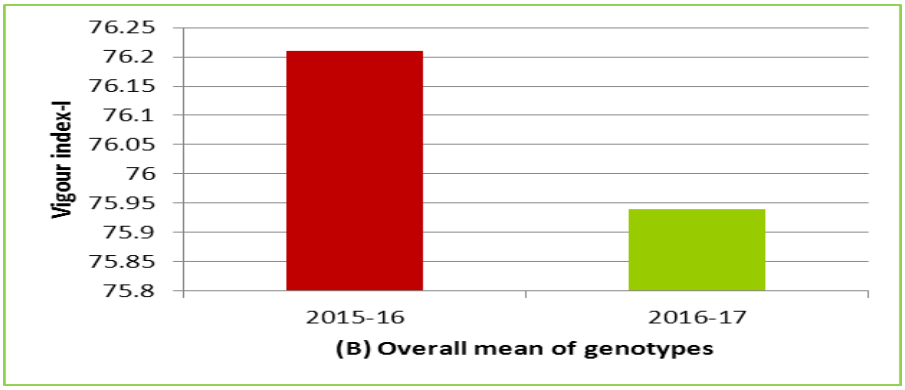
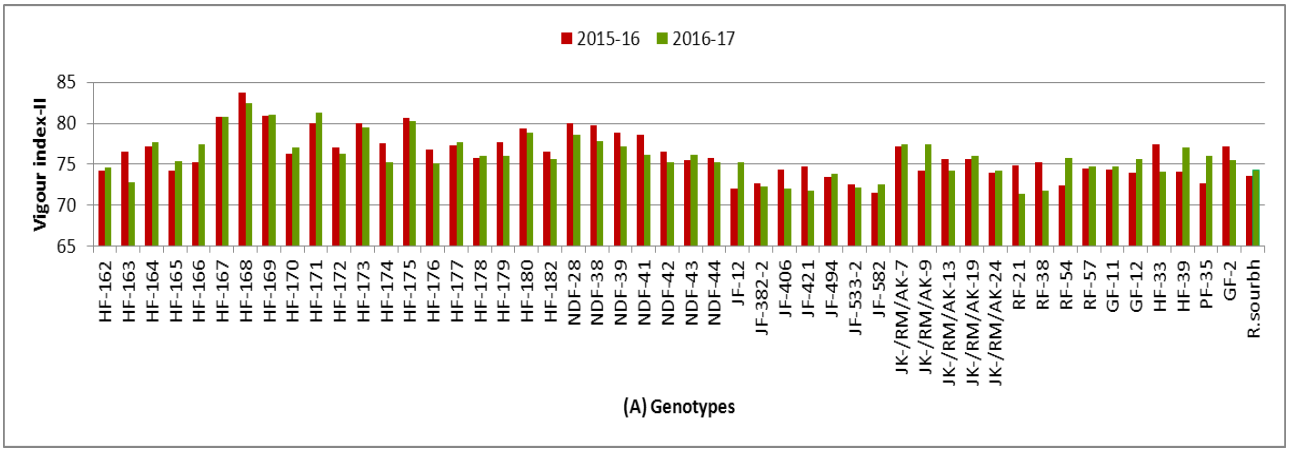


Fig 4: Vigour index-I of genotypes (A) and overall mean of genotypes (B)



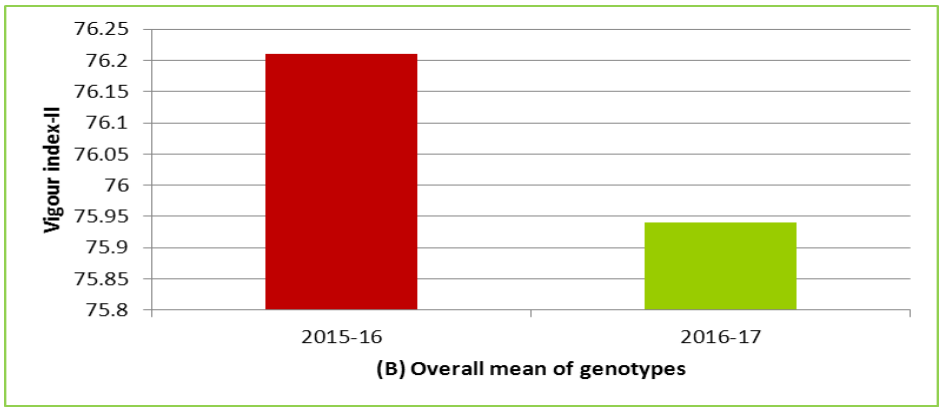


Fig 5: Vigour index-II of genotypes (A) and overall mean of genotypes (B)

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