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Growth, phenology, yield and economic parameters of coriander (*Coriandrum sativum* L.) under the influence of sowing dates and leaf cutting management

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ABSTRACT

The study was carried out at the College of Agriculture, JNKVV, Jabalpur to examine the effect of different sowing dates and cutting management on the growth, phenology, and yield of coriander. The key challenge was to decide the ideal time to implement both interventions, since the sowing date and the cutting of leaves is a sensitive matter due to the uncertainty of seasonal weather conditions. Furthermore, the possible stress condition of plants due to the interaction of suboptimal sowing and cutting of leaves made experiment very careful. The experiment followed factorial randomized block design, incorporating two factors: sowing dates and cutting management. A total of 20 treatments were implemented, each replicated three times. Coriander, an annual herb renowned for its culinary uses and pharmaceutical properties, was the subject of analysis. The parameters assessed included growth parameters, phenological parameters, yield parameters, and economic parameters. The tallest plant was observed in the treatment involving sowing on November 9th and single cutting (D9C1). The highest number of branches per plant was recorded in the treatment with sowing on 9 November and three cuttings (D9C3). The highest herbage yield was obtained from the treatment involving sowing on November 19th and 3 cuttings (D19C3). The highest seed yield was observed in the treatment with sowing on November 9th and no cutting (D9C0), while the treatment with sowing on November 9th and 3 cuttings obtained the maximum B: C ratio. The shortest time taken to flower was in the treatment with sowing on October 30th and no cutting (D30C0), whereas 50% flowering occurred earliest in the treatment involving sowing on November 29th and no cutting (D29C0). The study contributes significantly to studying spices because it offers data-oriented framework of defining the optimal sowing period that would give the maximum crop yield with simultaneously leaf cutting in coriander.

Keywords: *Phenology, Yield attributes, Coriander, Sowing dates, Cutting management, Economics.*

INTRODUCTION

India is the largest producer, consumer, and supplier of spices and one of the most important commodities of this sector is the coriander seed. India is producer of about 80 per cent of the global coriander seed [1]. Coriander (*Coriandrum sativum* L.) is an annual herb belonging to family Apiaceae (Umbelliferae) [2]. Fresh coriander leaves are utilized in the preparation of chutneys, sauces, and for flavouring curries, soups, and other dishes and its seeds are widely used as spices. Coriander possesses pharmaceutical properties, with its seeds serving as carminatives, refrigerants, aphrodisiacs, and diuretics. The coriander green stem, leaves and seeds has pleasant aroma [3] that is due to presence of essential oil 'coriandrol' ranging 0.1 to 1.3% in dry seed [4].

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Originating from the Mediterranean region, coriander is primarily cultivated in various countries including India, Morocco, Romania, France, Spain, Italy, Holland, Burma, Pakistan, Turkey, Mexico, Argentina, England, and USA. In India, coriander is cultivated in numerous states such as Madhya Pradesh, Gujarat, Rajasthan, Assam, Orissa, West Bengal, Tamil Nadu, Uttar Pradesh, Chhattisgarh, Bihar, Haryana, Maharashtra, Uttarakhand, Telangana, Andhra Pradesh, Karnataka, Mizoram, Himachal Pradesh, and Nagaland. In 2023, India produced more than 847,000 metric tons of coriander annually, which is approximately 68.58 percent of the world total. Other major producing countries are Iran, China and Morocco [5]. Domestically, Rajasthan produces the highest amount, and then comes the Madhya Pradesh, Andhra Pradesh, Tamil Nadu, Uttar Pradesh and Uttarakhand. In 2024, Madhya Pradesh produced 438.717 tonnes of coriander [6].

The production of coriander is a determined by a different factor, namely: genetics, weather and agronomy [7]. Coriander is typically grown in tropical regions, requiring cool weather conditions during the seed formation stage to enhance yield and produce quality.

The date of sowing is very crucial, influencing photoperiodic response, vegetative growth, yield and quality [8].The timing of sowing is a crucial factor affecting vegetative growth and crop yield. Early or late sowing can both accelerate plant growth, yield, and quality [9]. The sowing time determines the phonological development and efficient conversion of biomass into economically viable yield [10]. Changes in the sowing time influence the microclimates, and hence, the performance of crops. Optimizing the sowing time in relation to different growth stages of the crop is a crucial aspect of crop production that needs attention. Various meteorological parameters such as temperature, rainfall, humidity, and others can individually or collectively affect plant growth, production [9] .Coriander has rapid life cycle, which enables it to grow in different seasons, and it is flexible to grow in different climatic condition [11].

In the early stages, coriander crops can provide additional income to growers through leaf cutting. Multiple cuttings, typically 2-3, can be taken from coriander due to its regenerative capacity. Similarly, several cuttings can be obtained from other leafy vegetables. Under irrigated soil conditions, for leaf purposes, coriander can be grown throughout the year. India serves as the largest producer and consumer of fresh coriander leaves.

This study was carried out to determine optimum sowing date, level of cutting for increased leaf, and seed yield of coriander in the Jabalpur region of Madhya Pradesh.

MATERIALS AND METHODS

An experiment was conducted during the *Rabi* season of 2021-22 at the Vegetable Research Centre, Department of Horticulture, College of Agriculture, JNKVV, Jabalpur, Madhya Pradesh, India. The region experiences a hot and dry summer, followed by a cold winter with intermittent rainfall. The maximum temperature, peaking at 46°C, was recorded in April-May, while the minimum temperature was observed during December-January. The area receives an average annual rainfall ranging from 900 to 1250 mm. The experiment involved fives sowing dates (20th October, 30th October, 9th November, 19th November, and 29th November) and four cutting levels (0 cutting, 1 cutting, 2 cutting, and 3 cutting). The experiment was laid out on factorial randomized design with three replications, and each plot had dimensions of 3×2.4 m. The collected data was subjected to analysis of variance (ANOVA) using the techniques outlined by Panse and Sukhatame [12].

RESULT AND DISCUSSION

Growth parameters

Significant effect on growth parameters was observed from different sowing dates and cutting management (Fig 1). The tallest plant, measuring 118.33 cm, was obtained when sowing done on November 9 with one cutting (D9C1) (Fig 1a). The height of black cumin plants increased as sowing dates advanced until November 15, after which it rapidly declined [13]. Delayed sowing hindered the development, yield, and quality characteristics of the crop due to soil moisture depletion during the later stages of growth. Early sowing resulted in vegetative plant growth, likely due to more favourable climatic conditions and more sunlight throughout the growing season [14].

During the experiment, it was observed that cutting the foliage significantly reduced various growth parameters. Coriander plots where foliage cutting was not performed showed a significant increase in plant growth.

Similar findings were reported in Fenugreek [15] and Coriander [16], [17], [18]. The lowest plant height (90.53 cm) obtained in treatment combination of sowing on October 30 with three cuttings (D30C3). The findings were in line with those of [19] who observed that with the increased cutting frequency, plant height is decreasing. The growth and development of plants improved during later sowing dates due to favourable weather conditions throughout the vegetative period. Delayed sowing accelerated the crop's development because it experienced higher temperatures during vegetative growth [20].

When planted on November 9 with three cuttings (D9C3), the highest number of primary branches per plant at harvest was observed (Fig.1b). The results are in agreement with those of [21], who found that a single cutting at 45 DAS led to more number of branches per plant. [18] and [19] observed the same findings. On the other hand, sowing on November 29 with no cutting (D29C0) resulted in the lowest number of branches per plant. This finding aligns with [22], which indicated that later planting increases the number of branches per plant.

Phenological parameters

Based on the findings, the sowing conducted on October 30 without any cutting of the leaves (D30C0) exhibited an early onset of the first flowering phase, occurring after approximately 46.33 days (Fig. 1c). On the other hand, the sowing performed on November 29 with 3 cuttings (D29C3) required a longer duration of approximately 68.67 days for flowering to commence. In comparison to crops that underwent one or two cuttings, those without any cutting experienced an earlier initiation of the flowering process. These findings align closely with the research published by [23]. Moreover, when considering the time for 50% flowering, the sowing executed on November 19 with 3 cuttings (D19C3) necessitated a longer period of approximately 98.67 days, while the sowing conducted on November 29 without any cuttings (D29C0) required fewer days, approximately 56.23, for the 50% flowering stage (Fig.1d). Delaying the sowing process led to a reduction in the number of days required for 50% flowering to occur [9]. Early flowering is not a desirable characteristic of coriander as to farmers as it lowers the yield of green leaves.

Yield Parameters

Various treatments have a substantial effect on yield parameters in the cultivation of coriander, as presented in Table 1. The highest yield of herbage, 7645.50 kg/ha, was achieved with sowing date of 19 November and three cuttings (D19C3). While, the lowest herbage yield, amounting to 671.96 kg/ha, was obtained when sowing was done on 20 October with one cutting (D20C1). Increased yield of leaf after the third cut can be attributed by the fact that it has vigorous vegetative growth that resulted after the first cut. The results are in line with the findings in fenugreek [24] [25], black cumin [13], coriander [26] [23] and [18]. All the treatment which has 0 cutting has nil herbage yield as shown in the study conducted by [19] and [18], they also has no herbage yield in no cutting treatment.

Regarding the number of umbels per plant (69.47), number of umbellets per plant (6.23), number of seeds per umbel (32.97), seed yield per plant (4.7g), and seed yield per hectare (15.65 q), the highest values were observed when sowing was done on 9 November with no cutting (D9C0), while the lowest values were observed with sowing on 29 November and three cutting (D29C3). [14] Reported similar results in terms of the number of umbels per plant with a sowing date of 5 November, which was

supported by the findings of [22], [27], [28] and [9]. Higher biomass appears to contribute to a greater number of seeds per umbel [29]. Sowing of coriander on 5th November led to significant improvements in yield attributes, such as the number of umbels per plant, umbellets per umbel, seeds per umbel, test weight, seed weight per plant, and seed yield per hectare [9]. The yield-related parameters, such as the number of umbels per plant, umbellets per umbel, seed per umbel, umbel length and diameter, umbel weight, test weight, seed yield per plant, and seed yield per hectare, were significantly better when coriander was sown on October 25 than other sowing dates [2]. The results were in line with the findings of [26], [30] and [18] who reported that the highest seed yield was noted with one cutting.

The decrease in yield observed with later sowing dates could be attributed to insufficient time for vegetative growth, as the plants transitioned to the reproductive phase earlier. Plants that were not cut had a more number of leaves at the base of their stems, which acted as a sink and reduced seed output. This finding is consistent with the studies conducted by [29] and [19]. Conversely, [13] found that not cutting the plants resulted in significantly higher seed yields compared to a single cutting.

These findings align with those of conducted in Indian spinach [31], Fenugreek [24], Palak [32] [33] and Coriander [19]. The maximum values for yield were recorded when seeds were sown on 10 October, followed by 25 October, for all measured parameters [34].

Economics

The detailed economic analysis is presented in the heat map (Fig. 2). Scrutiny of the data revealed that the treatment combination without cutting recorded the lowest cultivation cost of ₹1, 01,019, whereas the combination involving three cuttings incurred the highest cultivation cost. Among all treatments, the 20 October sowing with two cuttings (D20C2) registered the minimum values for Gross Monetary Return (₹1, 85,754), Net Monetary Return (₹80,895), and Benefit–Cost Ratio (1.77). In contrast, the 9 November sowing with three cuttings achieved the maximum Gross Monetary Return (₹3, 18,254), Net Monetary Return (₹2, 11,475), and Benefit–Cost Ratio (2.98). These observations are in agreement with [18], who also reported that the treatment combination with two cuttings recorded the highest Benefit–Cost Ratio.

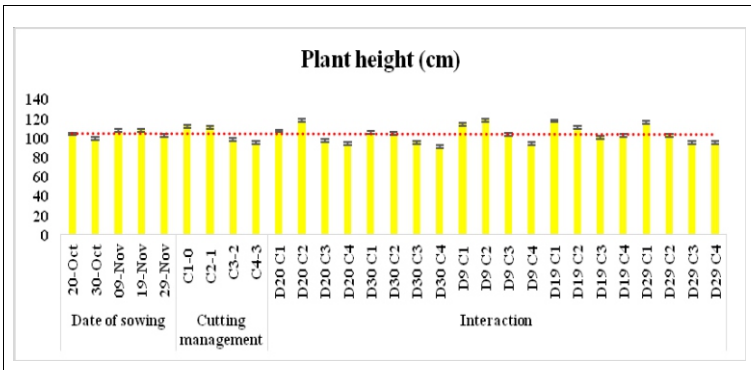

Fig. 1. Plant height at harvest

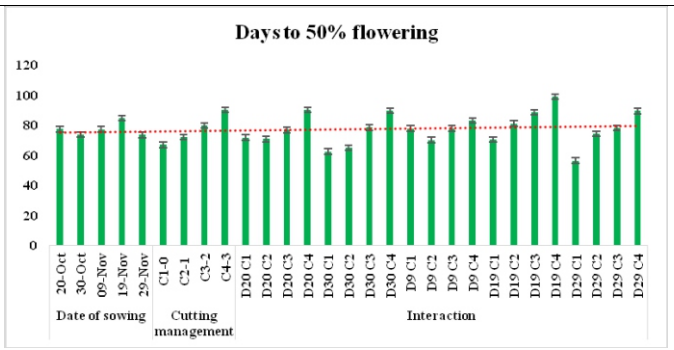

Fig.1b. Days to 50% flowering

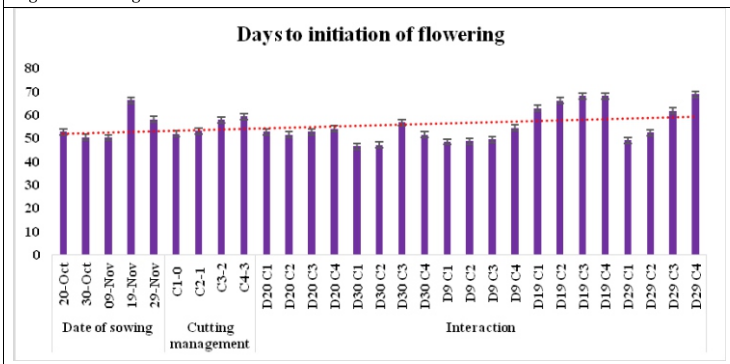

Fig.1c. Days to first flowering

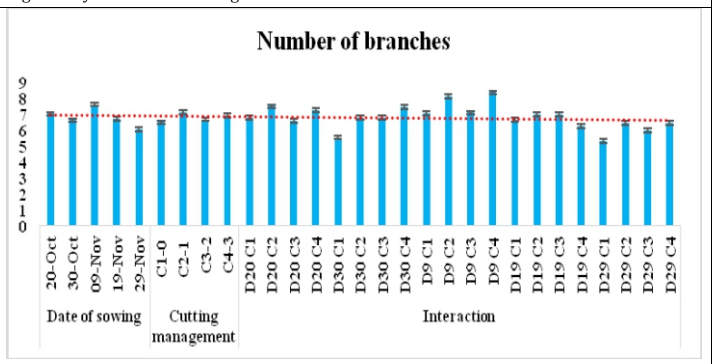

Fig.1d. No of branches per plant at harvest

Fig.1: Effect of sowing dates and leaf cutting on growth and phenological parameters of coriander

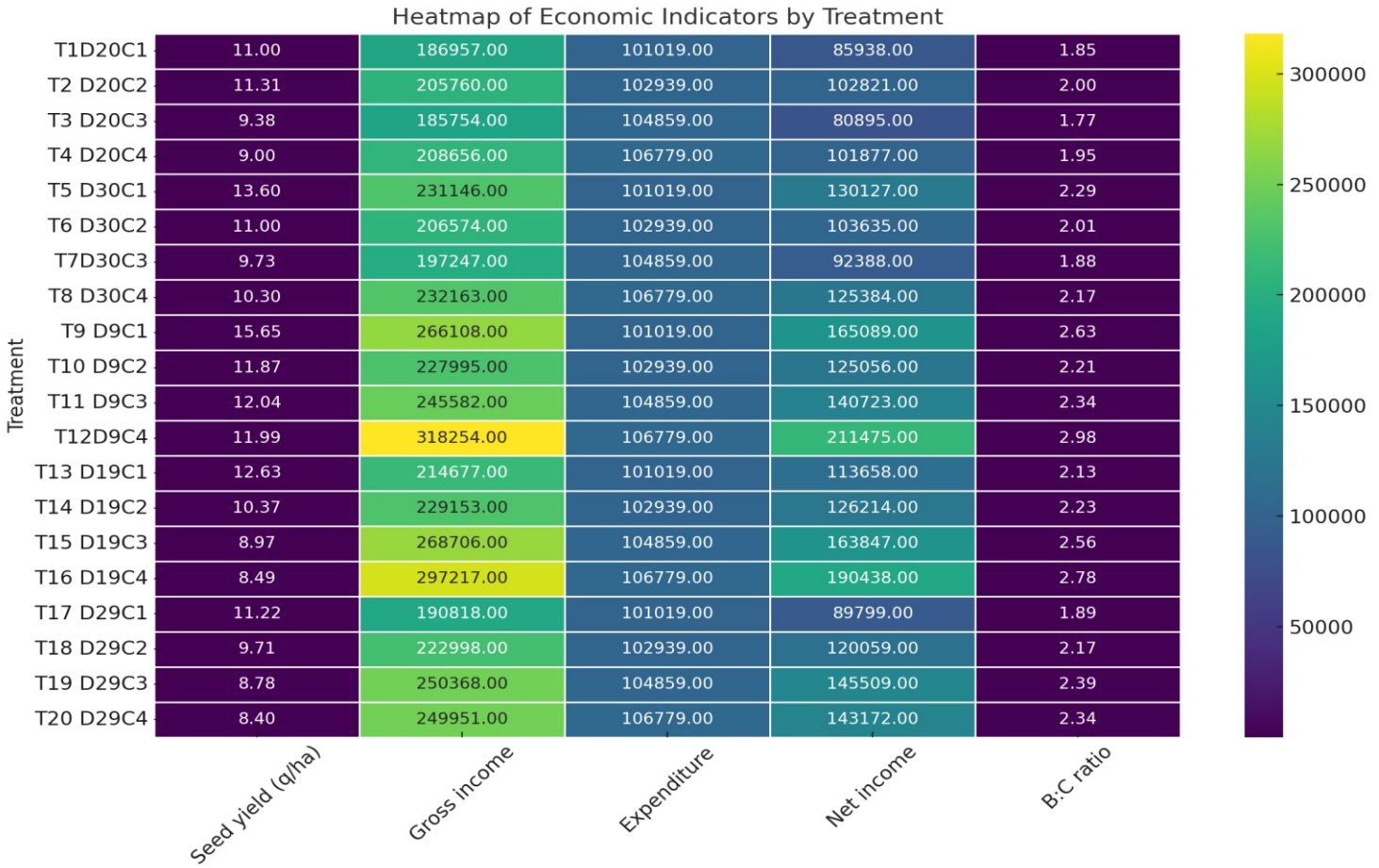

Figure 2. Heat Map of Economics of the treatments

Table 1: Effect of sowing dates and leaf cutting on yield and yield attributing traits

Treatment	Herbage yield per hectare(kg/ha)	Number of Umbel per plant	Number of umbellets per umbel	Number of seed per umbel	Seed yield per plant(g)	Seed yield (q/ha)	Test weight(g)
Date of sowing							
D20 (20 October)	1193.92	31.15	5.63	27.02	3.05	10.17	11.22
D30 (30 October)	1356.48	43.28	5.82	31.28	3.35	11.16	11.38
D9 (9 November)	2271.16	50.38	5.93	39.93	3.87	12.89	11.69
D19 (19 November)	4023.81	24.38	5.61	27.48	3.03	10.12	11.37
D29(29 November)	3327.38	21.03	5.31	24.68	2.86	9.53	11.19
S. Em ±	38.37	0.118	0.058	0.112	0.05	0.18	0.11
C.D.5% level	109.84	0.338	0.165	0.321	0.16	0.52	0.31
Cutting management							
C0 (0 cutting)	0.00	39.64	5.88	32.97	3.85	12.82	11.81
C1 (1 cutting)	1700.53	39.40	5.65	30.28	3.26	10.85	11.34
C2 (2 cutting)	3164.66	31.01	5.63	29.74	2.93	9.78	11.24
C3 (3 cutting)	4873.02	26.13	5.48	27.33	2.89	9.63	11.09
S. Em ±	34.32	0.106	0.052	0.100	0.05	0.16	0.10
C.D.5% level	98.24	0.302	0.148	0.287	0.14	0.47	0.28
Interaction							
T1 D20C0	0.00	19.73	6.21	24.97	3.30	11.00	11.51
T2 D20C1	671.96	32.73	5.60	28.50	3.39	11.31	11.41
T3 D20C2	1317.99	33.20	5.70	22.60	2.81	9.38	11.03
T4 D20C3	2785.71	38.93	6.20	32.00	2.70	9.00	10.95
T5 D30C0	0.00	60.53	5.71	30.23	4.08	13.60	11.61
T6 D30C1	978.84	45.13	5.60	27.77	3.30	11.00	11.70
T7 D30C2	1592.59	37.33	5.53	32.83	2.92	9.73	10.75
T8 D30C3	2854.50	30.13	5.69	34.30	3.09	10.30	11.47
T9 D9C0	0.00	69.47	6.23	47.80	4.70	15.65	13.40
T10 D9C1	1312.17	67.13	5.43	43.60	3.56	11.87	11.43
T11 D9C2	2047.62	36.47	5.93	40.97	3.61	12.04	10.76
T11 D9 C3	5724.87	28.47	5.67	27.37	3.60	11.99	11.17
T13 D19C0	0.00	23.80	5.90	30.07	3.79	12.63	11.23
T14 D19C1	2642.86	28.20	6.00	24.80	3.11	10.37	10.97
T15 D19C2	5806.88	27.53	5.47	31.17	2.69	8.97	11.67
T16 D19C3	7645.50	18.00	5.07	23.90	2.55	8.49	11.60
T17 D29C0	0.00	24.67	5.37	31.77	3.37	11.22	11.30
T18 D29C1	2896.83	23.80	5.59	26.73	2.91	9.71	11.20
T19 D29C2	5058.20	20.53	5.50	21.13	2.63	8.78	12.00
T20 D29C3	5354.50	15.13	4.77	19.07	2.52	8.40	10.26
S. Em ±	76.73	0.236	0.116	0.224	0.11	0.37	0.22
C.D.5% level	219.68	0.676	0.331	0.642	0.31	1.05	0.62

CONCLUSION

According to the findings of the current research, the maximum height of the plants was observed when the plants were sown on 9 November with a single cutting (Treatment 10). The maximum number of branches per plant was observed in Treatment 12 (9 November sowing and three cuttings). So 9 November is found to be superior in terms of growth parameters. Phenological data indicated that the days to first flowering was less in Treatment 5 (30 October sowing no cutting) and were at par with Treatment 6 (30 October sowing with one cutting). Treatment 17 (29 November sowing with no cutting) took minimum days for 50% flowering and it was at par with Treatment 5 (30 October sowing no cutting) indicating earliness is realized when sowing is done during the last week of October. Yield parameters pointed that maximum herbage yield of per plant and per hectare resulted in Treatment 16 (3 cuttings and sown on 19 November). Treatment 9 (9 November sowing and no cutting) gave the highest number of umbels to each plant and umbellets per umbel which is at par with Treatment 1 (20 October sowing and no cuttings). In Treatment 9, highest seeds yield per plant, seed yield per hectare, and highest test weight were obtained. Treatment 12 had the high gross monetary return, net monetary return as well as the highest benefit-cost ratio .From the given finding it is concluded that for leaf yield 3 cutting can be done and for seed yield no cutting. As for sowing date for both leaf yield and seed yield, November weather was good.

FUTURE SCOPE OF THE STUDY

The proposed future research needs to take place in a number of directions. To start with, there must be the incorporation of modern physiological methods. Exploring underlying processes e.g. hormonal changes, carbon partitioning, source- sink interactions will explain why the result of interactions between sowing date and leaf cutting are like this. Secondly, to make practical recommendations, it is necessary to scale the study to the field in multi-season conditions and use multiple genotypes to identify resilient cultivars. This could also be extended to verify the interaction of these factors with environmental stresses such as drought or levels of fertilizers to come up with resilient crop-management strategies. Lastly, it is essential to expand the study to multilocation trial over multiple season to validate the result.

Conflict of interest

There is no conflict of interest between authors.

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