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Evaluation of Dill (*Anethum graveolens* L.) genotypes for growth and seed yield attributing characters

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Abstract
Dill (*Anethum graveolens* L.) is belongs to seed spice crops. It is also a important medicinal and aromatic crop. The research experiment on "Evaluation of Dill (*Anethum graveolens* L.) genotypes for growth and seed yield attributing characters" was conducted at Horticultural Research & Extension Centre, Devihosur, Haveri, University of Horticultural Sciences, Bagalkote, Karnataka during *rabi* Ist year (2021-22) & IInd year (2022-23) to know the different dill genotypes performance for growth and seed yield attributing characters. Among the different genotypes of the dill *viz*., DDC-1, DDC-2, DDC-3, DDC-4, DDC-5 & two varieties namely AD-1, AD-2 (check varieties) for both the years differed significantly. The pooled data for evaluation of different genotypes of dill, the genotype DDC-5 recorded significantly the highest plant height (139.65 cm) at harvest stage, primary branches (6.70 No./plant), secondary branch (15.15 No./plant), umbels (46.85 No./plant), number of umbellets (49.30 No./umbel), No. of seeds (31.80/umbel), seed yield (16.85 g/plant) & seed yield (14.55 q/ha) at harvest stage followed by the variety AD-1 plant height (137.65 cm), primary branches (5.55 No./plant), secondary branch (14.35 No./plant), umbels (42.85 No./plant), number of umbellets (46.70 No./umbel), No. of seeds (28.05/umbel), seed yield (15.55 g/plant) & seed yield (13.18 q/ha) at harvest stage. While, the lowest plant height (124.20 cm), number of primary and secondary branches (4.50 & 12.05 No./plant), umbels (31.15/plant), umbellets (25.70/umbel), No. of seeds (20.50/umbel), seed yield per plant (10.50 g/plant) & seed yield per ha (8.11 q/ha) was recorded by DDC-2.

Keywords: Dill, genotypes, plant height, umbel, umbellets, seed yield

Introduction
Dill (*Anethum graveolens* L.) is an important seed spice crops, medicinal and aromatic plant belongs to *Apiaceae* family. Dill is a origin of south west Asia or may be a native of south east europe. The *Anethum* genus name is obtained from Greek word aneeson which indicates a strong smell of dill leaves. In India all most all the states grown as *rabi* or winter season crop for commercial purpose. In the states of Andhra Pradesh, Gujarat, Karnataka, Maharashtra, Madhya Pradesh and Rajasthan for seed purpose, dill crop was grown in the name of sowa and it is also named as Indian Dill. Mainly the leaves are used for vegetable purpose and seeds widely used for spice purpose because its pleasant spicy aroma and plenty of nutritional and medicinal properties (Jana and Shekhawat, 2010) [8]. It is also used for the purpose of flavoring of tea and pickles. The crop leaves are rich in minerals and fibers. The seeds are useful for spice and medicinal purpose and leaves used as a vegetable and aromatic herb (Sharma, 2004) [20]. The aroma volatiles of seed and leaves of dill have many therapeutic properties and the anti-microbial activities of carvone (terpenoid) isolated from dill seed oil (Agarwal *et al*., 2002) [11]. It is also used for the curing of the many health issues like urinary infections, piles problems and mental health disorders (Nair and Chanda, 2007) [15].
In India 32.79 thousand ha area with a production of 34.56 thousand tonnes and productivity of 1054 kg/ha dill crop was recorded during 2020 (DASD, 2020) [5]. Dill is a cross-pollinated crop with protandrous in nature bearing a small flowers in colour and diploid (2n = 22) chromosome number. The inflorescence is a small small yellow flowers with compound umbel type. The umbel is on an average of 4-16 cm in diameter and flowers are blooming in a sequential order.

The flower blooming was initiated first at main umbel and followed by the remaining umbels present in the plant (Nemeth & Szekely, 2020) [17]. Duration of the inflorescence is completed within 10–12 days and stigma receptivity is continued up to midday depending upon the ambient temperature and anthers dehiscence will take place during the morning hours (Weiss, 2002) [23]. Dill inflorescence are hermaphrodite and homogamous in nature. Hermaphrodite means both male and female reproductive parts are present in the same flower and these two are matured at a same time is called as homogamous flowering nature. In dill inflorescence type, the sometimes the umbels are having fully pistillate type of flowers or some staminate flower types and only few are hermaphrodite in nature. In umbels the flower bearing type is the primary umbels bear hermaphrodite flowers. Hermaphrodite flowers bear once in the margin of the umbels and staminate flowers are in the centre in case of secondary and tertiary umbels. In dill flowers, pistillate flower contains ovary of the two ovals. The insect attraction for the pollination work, specially for bees, flies and other pollinating insects, the staminate flowers contain sufficient quantity of nectar with strong odour (Peter, 2012) [18]. Mainly the honey bee species *Apis florea* as recorded as the main pollinating insects for dill crop (Meena, 2015) [14].

For vegetable purpose dill grows up to the height of 40-60 cm and for seed purpose it will grows up to the height of 145 to 150 cm. It can be cultivated almost all types of soil except sandy loam soil, most suitable for well drained loose soil with soil pH range of 5.3 to 7.8. The crop is moderate tolerance to the frost during vegetative stage and for seed production purpose the crop requires the congenial environment like dry climate with relatively high temperature and this crop come up well during the warm to hot summer with more sunshine hours and even partial shade will reduce the yield levels. High humid environment favours the incidence of diseases and pests, specially aphid and powdery mildew.

The seeds are smaller in size, flattened shape and lighter in seed weight with a pleasant aromatic odour. Propagation is mainly through seeds and seed viability is present up to 3-10 years. The seeds are harvested by cutting the umbels when the seed is beginning to ripe. The dill is ecologically good companion crop for corn, cabbage, lettuce and onions but it inhibits growth of carrot crop.

However, dill is grown during the *rabi* season, yield is a complicated parameter governed by several yield attributing parameters. Since, the most of the yield parameters are quantitatively inheritance character and highly influenced by the environmental factors. It's very complex to judge whether the recorded yield parameters are observed in different genotypes were really heritable or some other parameters like environmental factors, agronomic practices and time & method of harvesting. Hence, the present study was under taken to study the evaluation of dill genotypes for growth and seed yield attributing characters.

Materials and Methods

The field experiment was conducted at Horticultural Research & Extension Centre, Devihosur, Haveri, University of Horticultural Sciences, Bagalkote, Karnataka during *rabi* Ist year (2021-22) & IInd year (2022-23) to know the different dill genotypes performance for seed yield. The center is located in Northern transitional agro-climatic zone (zone-8) at 14 ^{0} 47′ latitude and 75 ^{0} 21′ E longitudes & 563 m above MSL. Soil type is black with medium depth. The annual rainfall is 750 mm. The mandate crops are chilli and seed spices. There were five different devihosur dill collection (DDC) genotypes *viz*., DDC-1, DDC-2, DDC-3, DDC-4, DDC-5 & two varieties namely C1: AD-1 (Ajmer dill-1), C2:AD-2 (Ajmer dill-2) as check varieties. The net plot size was 2 X 2 m^2 and sown the seeds with a spacing of 45 x 10 cm distance. The experimental design was randomized block design with one factor and treatments were replicated in twice. In the limited irrigation facilities all recommended agronomic practices were followed to get a good quality seeds. Since dill is a cross pollinated crops naturally exhibits out crossing, hence to avoid the contamination, the safe isolation distance of 200 meters was maintained from other crop field to get a good quality seed yield of different genotypes of dill. The different crop growth stages like vegetative, flowering and seed filling to maturity stages the strict rouging operations were carried out to get the good quality seeds. The five randomly selected plants of different genotypes in each replications recorded the observations on plant height (cm), number of branches (primary & secondary), number of umbels per plant, number of umbllets per umble, number of seeds per umbel (g), seed yield per plants (g), seed yield per ha (q/ha), The net plot yield was used for calculation of seed yield per ha and separately recorded yield parameters for different genotypes and varieties with due care. The collected data was statistically analyzed.

Results and Discussion

The results obtained from the present investigation on performance of different genotypes of dill differed significantly with respect to growth and seed yield attributing characters during 2021-22, 2022-23 & pooled data as presented in table.1 & 2. The analysis of variance was calculated for all growth and seed yield parameters of different genotypes of dill and mean of different parameters were presented in table. 1 & 2. The data pertaining to plant height (cm) at harvest, primary branches (No./plant), secondary branch (No./plant) and umbels (No./plant) differed significantly during the both the years as well as on pooled data.

In pooled data analysis, among the genotype, DDC-5 at harvest stage found superior by recording the significantly the highest plant height (139.65 cm), primary branches (6.70 No./plant), secondary branches (15.15 No./plant) and umbels (46.85 No./plant). Similarly, the variety AD-1 recorded the second highest values *viz*., plant height (137.65 cm) at harvest, primary branches (5.55 No./plant), secondary branches (14.35 No./plant) and umbels (42.85 No./plant). The genotypes DDC-2 recorded the lowest plant height (124.20 cm) at harvest, primary branches (4.50 No./plant), secondary branches (12.05 No./plant) and umbels (31.15 No./plant) table.1. This might be due to the differences of genotypic potentiality among the different genotypes and acclimatization of the particular genotype to the season, location and management practices. The morphological differences among the genotypes are may be due to the genetic constituents of the particular genotype. The similar results were reported by Malhotra and Vashista (2007) [12] in dill and Balai *et al.,* (2011) [3] in coriander. These results are also conformity with Selvarajan and Chezhiyan (2001) [19], Hellal *et al*., (2011) [7] and Kushbhu Kumari *et al*., (2017) [22]. Genetic potentiality of a particular genotypes with proper management of the crop will enhanced the crop growth in terms of number of branches per plant also reported by Kumar *et al*., (2002) [11]. Similar findings were reported by Solanki *et al.,* (2014) [21] & Raut *et al*., (2020) [2] in dill and Jyothi *et al*., (2017) [9] & Dhakad *et al*., (2017) [6] in Coriander.

In pooled data of different genotypes of both the years (table.2),

the genotype DDC-5 reported the maximum number of umbellets (49.30 No./umbel), No. of seeds (31.80/umbel), seed yield (16.85 g/plant), Seed yield (14.55 q/ ha) and followed by the variety AD-1 number of umbellets (46.70 No./umbel), No. of seeds (28.05/umbel), seed yield (15.55 g/plant), seed yield (13.18 q/ha). While, the lowest number of umbellets (25.70/umbel), number of seeds (20.50 /umbel), seed yield (10.50 g/plant), seed yield (8.11 q/ha) was recorded by the genotype DDC-2 (table 2). A variation for these character is found to be quite high which might be responsible for the wide range in yield potential of different genotypes. A wide range of variation existing for various quantitative traits has also been reported in Dill by Meena *et al*.,(2015) [8]. Similar pattern of variability in germplasm evaluation of different sizes for various traits in dill have earlier been reported by Yadav *et al*.,(2017) [22], Jyothi *et al*.,(2017) [9] and Nandkumar *et al*.,(2018) [16]. Accord into pooled data of the both years The DDC-5 & AD-1 recorded the significantly higher number of seed/umbel and seed yield per plant/ha This may be due to the inheritance effect of the particular genotype and these genotypes had high genetic and heritability coupled with high genetic advances mean indicating the predominance of additive gene action (Raut *et al*., 2020) [2]. The increased photosynthesis might have enhanced the number of flowers and their fertilization resulting in higher number of seeds per umbel and seed yield. These results were agreed with the findings of the Meena *et al*.,(2017) [13] and Darzi *et al*.,(2012) [4].

Based on the performance of the growth and yield parameters of the different genotypes and check varieties, the growth and yield components showed the positive influence on the seed yield. It indicating that more plant height at harvest, number of branches per plant, number of umbels per plant, number of umbellets per umbel, number of seed per umbellets and seed yield will be more useful in identifying the dill genotypes as further breeding programme for crop improvement studies. This may be due to the effect of particular genotype or variety response to the environmental season and agronomic management of the crop. These phenotypic traits will helpful for further selection of the new genotype for breeding programme. The highest plant growth, seed yield & yield attributing characters were found in the genotype DDC-5 & AD-1 will helpful for further crop improvement programme.

Table 1: Evaluation of Dill Genotypes for Plant height (cm), Primary branches (No./plant), Secondary branches (No./plant) & Umbels (No./plant)

Geno types	Plant height (cm)			Primary branches (No./plant)			Secondary branches (No./plant)			Umbels (No./plant)		
	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled
DDC-1	135.51	134.4	134.96	5.5	5.4	5.45	11.4	15.6	13.50	36.5	35.4	35.95
DDC-2	122.24	127.4	124.82	4.8	4.2	4.50	10.4	16.4	13.40	35.0	33.2	34.10
DDC-3	122.7	129.0	125.85	5.7	4.8	5.25	9.3	14.8	12.05	34.8	28.6	31.70
DDC-4	131.8	131.4	131.60	4.7	5.2	4.95	10.5	15.6	13.05	33.5	28.8	31.15
DDC-5	133.7	140.4	139.65	6.6	6.8	6.70	13.3	17.0	15.15	48.5	45.2	46.85
C-1	135.5	139.8	137.65	6.0	5.6	5.55	12.2	16.4	14.35	44.9	40.8	42.85
C-2	124.6	123.8	124.20	5.1	5.1	4.85	13.4	12.2	12.80	30.1	32.6	31.35
Mean	130.15	132.31	131.25	5.49	4.6	5.32	11.36	15.43	13.39	37.61	34.94	36.28
SEM	0.26	0.27	0.30	0.25	0.15	0.10	0.45	0.22	0.32	1.10	1.15	1.01
CD	0.78	0.81	0.90	0.75	0.45	0.30	1.35	0.66	0.96	3.30	3.45	3.03
CV%	7.76	6..75	4.25	6.25	2.25	4.56	6.23	5.63	7.25	4.25	5.26	3.45

C-1: AD-1 (Ajmer dill-1), C-2:AD-2 (Ajmer dill-2)

Table 2: Evaluation of Dill Genotypes for yield attributing characters,

Geno types	Umbellets (No./umbel)			No. of seeds/Umbel			Seed yield (plants /g)			Seed yield (q/ha)		
	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled	2021-22	2022-23	Pooled
DDC-1	38.90	35.00	36.95	20.00	21.00	20.50	11.20	12.20	11.70	10.85	9.13	9.99
DDC-2	29.20	22.20	25.70	25.20	20.40	22.80	12.50	10.50	11.50	9.85	6.38	8.11
DDC-3	29.20	35.00	32.10	26.80	21.40	24.10	13.00	8.50	10.75	8.30	8.63	8.46
DDC-4	27.80	25.60	26.70	24.70	23.00	23.85	11.50	9.50	10.50	10.68	12.63	11.65
DDC-5	45.40	53.20	49.30	33.00	30.60	31.80	16.20	17.50	16.85	14.10	15.00	14.55
C-1	42.70	50.80	46.70	28.30	27.80	28.05	15.50	15.60	15.55	13.85	11.25	13.18
C-2	37.30	32.40	34.80	23.80	20.60	22.20	11.00	12.20	11.60	11.85	8.38	10.11
Mean	35.79	36.31	36.10	25.97	23.54	24.76	12.99	12.29	12.64	0.99	0.96	0.98
SEM	1.25	1.27	1.29	1.21	1.24	1.26	0.96	0.45	0.35	0.35	0.47	0.48
CD	3.75	3.81	3.87	3.70	3.72	3.78	2.88	1.35	1.05	1.05	1.41	1.44
CV%	6.48	5.56	4.25	5.46	4.16	3.25	5.56	4.78	5.63	6.25	7.25	4.25

C-1: AD-1 (Ajmer dill-1), C-2: AD-2 (Ajmer dill-2)

Conclusion

Among the different genotypes of the dill, the genotypes DDC-5 & AD-1 showed better performance especially in respect of growth and seed yield traits. Therefore, these genotypes can be taken for consideration for further crop improvement programmes.

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