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Effect of irrigation, FYM and storage conditions on seed oil content of European dill (*Anethum graveolens* L.)

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Abstract

A field and laboratory experiment was conducted to investigate the effect of irrigation and farmyard manure as well as storage conditions on oil content of medicinal plant, dill (*Anethum graveolens* L.). At field level, treatments *viz.*, 4 levels of irrigation scheduled at 50 (I_{50}), 100 (I_{100}), 150 (I_{150}) and 200 (I_{200}) mm CPE and 3 levels of farmyard manure like 0 (F_0), 15 (F_{15}) and 30 (F_{30}) t FYM ha^{-1} were conducted for two seasons from 2005-06 and 2006-07 in completely randomized blocks with 3 replications and in laboratory, oil was extracted from seeds stored upto 90 days and kept at cloth bag at room temperature, cloth bag in deep fridge, poly bag at room temperature, poly bag in deep fridge. In general, results of the present study revealed that for higher oil content of European dill, crop must be irrigated at 100 mm CPE and fertilized with 15 to 30 t ha^{-1} FYM and Seeds may be stored in polythene bag at room temperature for two months without loss of oil content.

Key words: *Anethum graveolens*, Ayurvedic uses, Irrigation, FYM, Storage condition, Oil content.

In medicinal plants, the content of metabolite is economically more important than the yield of the plant part containing the metabolite, as it determines the cost of its extraction[6]. *Anethum graveolens* L. (dill) has been used in Ayurvedic medicines since ancient times and it is a popular herb widely used as a spice and also as a source of essential oil. It is an aromatic and annual herb of *Apiaceae* family. The Ayurvedic uses of dill seeds are as carminative, stomachic and diuretic. It is used in *Unani* medicine in colic, digestive problems and also in gripe water[2]. European dill has a good demand in the country and recently it has also developed great potential for export in the international market. The price of European dill seed oil is about Rs. 2500/ kg[12].

In view of above, the present study

was carried out.

The field experiment was conducted with treatments comprising 4 levels of irrigation scheduled at 50 (I_{50}), 100 (I_{100}), 150 (I_{150}) and 200 (I_{200}) mm CPE and 3 levels of soil fertility *viz*, 0 (F_0), 15 (F_{15}) and 30 (F_{30}) t FYM ha^{-1}, in factorial randomized block design with three replications, during *rabi* seasons (December to May) of 2005-06 (first year) and 2006–2007 (second year) at N.E.B. Crop Research Centre of G. B. P.U.A& T., Pantnagar, US Nagar, Uttarakhand. The soil of the experimental field was sandy loam in texture, rich in organic carbon content (0.83%), low in available nitrogen (224.19 kg ha^{-1}), medium in available phosphorus (20.67 kg ha^{-1}) and potassium (146.74 kg ha^{-1}) and neutral in reaction (pH 7.78). During the growing period, out of the total 145.6 and 55.6 mm rainfall maximum 47.6 and 34.4 mm were received in the month of January, 2005 and May, 2007 during first and second year, respectively. The crop was sown two years from 2005-07 during winter (*rabi*) season in month of December using seed rate of 5 kg ha^{-1} and harvested during summer in May. Well decomposed and pulverized farmyard manure (FYM) broadcasted carefully in different amounts in each plot as per treatments. Subsequent irrigation treatments were scheduled based on cumulative pan evaporation (CPE) data. Irrigation water was measured with the help of *Parshall* flume under free flow conditions fixed in the irrigation channel to provide water upto 6 cm depth of soil at each irrigation.

The crop quality was judged by extracting oil from seeds. For obtaining seed oil, water distillation method using Clevenger's type glass distillation apparatus was used. Immediate after crop harvesting, essential oil was distilled from seeds after threshing. Distillation process for each sample continued for 3 hours. The essential oil content was calculated using formula:

$$\text{Essential oil content (\% volume/weight basis)} = \frac{\text{Quantity of essential oil (ml)}}{\text{Weight seeds (g)}} \times 100$$

The statistical analysis of the data was done by following the procedure for analyzing Factorial Randomized Block Design[1]. The critical difference for comparing the treatment means at 5% level of probability was computed wherever the F-test was significant.

Fresh seeds :

Oil content in fresh seeds was found to be significantly higher when crop was irrigated at 200 mm CPE compared to remaining levels during first year. These differences disappear during second year, where irrigating the crop at 150 mm CPE level caused highest oil content. Because stress conditions accelerate the biosynthesis of essential oils[3]. The essential oil percentage of dill significantly improved, when plants were subjected to water stress[5] as water stress imposed by restricting the number of irrigations increased the percentages of volatile oils in parsley and fennel[10].

Application of FYM caused significant increase in oil content in fresh seeds with increasing rates upto 15 t FYM ha^{-1} and thereafter reduced significantly during first year, whereas during second year application

Table-1. Oil content (%) in fresh and 30 days stored seeds under different conditions as influenced by the treatments

Treatments	Oil content (%)									
	Fresh seeds		30 days stored seeds							
			CBRT		CBDF		PBRT		PBDF	
	I	II	I	II	I	II	I	II	I	II
Irrigation levels (mm CPE)										
50	2.05	2.64	1.47	1.53	1.60	1.64	1.51	2.51	1.07	1.73
100	2.13	2.71	1.56	1.67	1.73	1.84	1.61	2.64	1.36	1.64
150	2.08	2.85	1.89	1.78	1.88	1.93	1.82	2.13	1.49	1.93
200	2.26	2.82	1.74	1.73	1.89	1.87	1.62	1.67	1.45	2.04
C.D. at 5 %	**0.12**	**NS**	**0.08**	**0.16**	**0.12**	**0.16**	**0.13**	**0.13**	**0.09**	**0.12**
FYM levels (t ha^{-1})										
0	1.69	2.55	1.50	1.57	1.55	1.65	1.48	2.15	1.17	1.70
15	2.19	2.73	1.63	1.63	1.78	1.85	1.64	2.33	1.35	1.85
30	2.55	2.98	1.85	1.83	2.00	1.97	1.80	2.38	1.50	1.97
C.D. at 5 %	**0.11**	**0.19**	**0.07**	**0.14**	**0.11**	**0.14**	**0.12**	**0.12**	**0.08**	**0.10**

of 30 t ha^{-1} FYM caused significantly more oil content in seeds compared to 0 and 15 t ha^{-1} FYM levels (Table-1) due to organic compost caused significant increase essential oil extracted from plants[11].

Thirty days stored seeds :

The oil content in seed collected from different irrigation treatments increased significantly with increase in CPE level upto 150 mm when seeds were stored in cloth bag at room temperature (CBRT), cloth bag in deep fridge (CBDF) and polythene bags in deep fridge (PBDF) during first year (Table 1).

Increasing levels of FYM caused significant increase in oil content when seeds were kept in CBRT, CBDF and PBRT during first year, and PBDF during both the years while during second year, seeds collected from 30 t FYM ha^{-1} treatment had significantly more oil content compared to 0 and 15 t FYM ha^{-1} when kept in CBRT. Seeds collected from 15 and 30 t ha^{-1} FYM contained similar oil which was significantly more than no FYM, when stored in CBDF and PBRT during second year (Table-1).

Sixty days stored seeds :

The data on oil content in seeds stored under different conditions for 60 days are presented in Table 2. Oil content was found to

Table-2. Oil content (%) in 60 days stored seeds under different conditions as influenced by the treatments

Treatments	Oil content (%)							
	CBRT		CBDF		PBRT		PBDF	
	I year	II year	I year	II year	I year	II year	I year	II year
Irrigation levels (mm CPE)								
50	1.71	1.73	1.60	1.78	1.91	2.33	1.89	2.55
100	1.89	1.87	1.87	2.02	2.24	2.56	2.15	2.76
150	1.96	2.27	2.22	2.25	2.38	2.78	2.29	2.89
200	1.82	2.22	2.13	2.16	2.40	2.67	2.27	2.89
C.D. at 5 %	**0.13**	**0.11**	**0.11**	**0.10**	**0.12**	**0.12**	**0.13**	**0.11**
FYM levels (t ha^{-1})								
0	1.72	1.78	1.78	1.95	2.15	2.30	1.97	2.65
15	1.83	2.07	1.98	2.03	2.18	2.65	2.17	2.80
30	1.98	2.22	2.10	2.17	2.37	2.80	2.32	2.87
C.D. at 5 %	**0.11**	**0.09**	**0.09**	**0.09**	**0.11**	**0.10**	**0.11**	**0.09**

be significantly more when crop was irrigated at 150 and 200 mm CPE level compared to remaining CPE irrigation levels in all the storage conditions during both the years except in seeds stored in CBRT during first year where 100 and 150 mm CPE irrigation levels caused similar oil content. Seeds stored in PBRT produced significantly more oil content due to 150 mm CPE, being at par with 200 mm CPE, compared to remaining irrigation treatments. In all the storages conditions, significantly higher oil content was recorded when 30 t FYM ha^{-1} was applied compared to no and 15 t ha^{-1} FYM except in seeds stored in PBDF where 15 and 30 t FYM ha^{-1} caused similar and significantly increased oil content compared to no FYM application.

Ninety days stored seeds :

The data on oil content in 90 days stored seeds under different storage conditions are presented in Table-3. Irrigation given at 150 and 200 mm CPE caused similar oil content which was significantly more than remaining irrigation treatments in all the storage conditions during both the years except during first year where irrigation at 100 mm CPE level also increased oil content significantly when seeds were stored in PBDF, while oil content in seeds stored in CBRT increased significantly due to 150 and 200 mm CPE level, being at par with 100 mm CPE level, compared to 50 mm CPE irrigation treatment. CBDF stored seeds contained highest oil when

collected from 100 and 150 mm CPE irrigation treatments during both the years but during first year it was also found at par with 200 mm CPE level. Oil content reduced significantly when crop was irrigated at 50 mm CPE in all the storage conditions during both the years except in seeds stored in cloth bag at room temperature during both the years where seeds collected from 50 and 100 mm CPE irrigation treatments contained similar oil.

Oil content increased significantly with increase in levels of FYM upto 30 t ha^{-1} under all the storage conditions during both the years except during first year seeds stored in CBDF and during second year, in seeds stored in PBDF where seeds collected from 15 and 30 t ha^{-1} FYM treatments contained similar oil.

Increased oil content under limited moisture supply may be because water stress has been found to affect the composition of oil and thereby oil content. Drought stress led to increased essential oil percentage, whereas the greatest essential oil percentage obtained when 60% FC was applied[4]. The seeds collected from 100 mm CPE irrigation treatment and stored in PBRT may have experienced high temperature during storage at which the oxygenated compounds in oil increased leading to more oil content. Seeds stored for 60 and 90 days storage under different conditions contained highest oil when collected from 150 mm CPE irrigated plots. This indicates that longer storage of seeds, the oil content does not fluctuate much irrespective of storage conditions.

Table-3. Oil content (%) in 90 days stored seeds under different conditions as influenced by the treatments

Treatments	Oil content (%)							
	CBRT		CBDF		PBRT		PBDF	
	I year	II year	I year	II year	I year	II year	I year	II year
Irrigation levels (mm CPE)								
50	1.51	1.60	1.49	1.58	1.73	1.87	1.69	1.74
100	1.64	1.67	1.82	1.93	1.93	2.00	1.89	1.96
150	1.71	1.82	1.91	1.87	2.20	2.29	1.98	2.16
200	1.67	1.75	1.86	1.80	2.16	2.22	1.91	2.13
C.D. at 5 %	**0.15**	**0.13**	**0.12**	**0.11**	**0.17**	**0.12**	**0.11**	**0.10**
FYM levels (t ha^{-1})								
0	1.50	1.51	1.60	1.70	1.77	1.97	1.75	1.77
15	1.63	1.72	1.80	1.84	2.02	2.10	1.85	2.02
30	1.77	1.90	1.91	2.06	2.23	2.22	2.00	2.10
C.D. at 5 %	**0.12**	**0.11**	**0.11**	**0.09**	**0.14**	**0.11**	**0.09**	**0.09**

Farmyard manure application did not cause much influence in the oil content of seed under different storage conditions and periods. It suggests that farmyard manure could provide definite nutrients for synthesis and stability of essential oil in the seeds[7&8]. Nutrient fertilization may have enhanced the essential oil biosynthesis process through its direct or indirect role in plant metabolism which resulted in more plant metabolites. Nitrogen fertilizer was effective in essential oil of *Ocimum americanum* L[9].

So it can be concluded that European dill may be irrigated at 100 mm CPE and fertilized with 15-30 t FYM ha^{-1}. Crop may be irrigated at 60, 90 and 105 days after sowing depends on rainfall. Seeds may be stored for two months in polythene or polythene lined bags under room temperature without loss of oil content.

Abbreviation used: CBRT- Cloth Bag at Room Temperature, CBDF- Cloth Bag in Deep Fridge, PBRT- Poly Bag at Room Temperature, PBDF- Poly Bag in Deep Fridge, CPE- Cumulative Pan Evaporation, FYM- Farmyard Manure, C.D.-Critical Difference

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