Research Article

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QUANTITATIVE EVALUATION OF INDUCED MACROMUTANTS IN FENNEL (*FOENICULUM VULGARE* MILL.)

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ABSTRACT

Macromutants namely, thick stem, slender stem, pigmented stem, dwarf, elongated pinnae, narrow pinnae and early flowering are screened at M_2 generation (total plants screened - 1575) following exposure of dry seeds (moisture content – 9.3%) of fennel (*Foeniculum vulgare* Mill., Family: Umbelliferae) to different doses/concentrations of γ-irradiations and EMS. Selfed lines of the mutants are evaluated in M_6 generation in comparison to control considering eight phenotypic traits (plant height, number of primary branches/plant, total branches/plant, number of compound umbels/plant, number of umbels/plant, number of umbellets of first inflorescence, seed yield and harvest index). Statistical test (Duncan's test at 5% level of significance) reveal that thick stem mutant is a promising mutant for direct use; while, the rest may be exploited by efficient breeding.

Keywords: Fennel, Macromutants, Traits, Evaluation

INTRODUCTION

Fennel (*Foeniculum vulgare* Mill., Family: Umbelliferae; 2n=22) is one of the widespread economically very important seed spices of India. Besides using it as spice in culinary art, it is also used in cosmetic and pharmaceutical products[1]. The essential oil of fennel has a valuable antioxidant[2-6], antimicrobial[4-9], antispasmodic[10], anticancerous[11-13], antidiabetic[14], antithrombotic[15], hepatoprotective[16], even memory enhancing[17] activity. The diuretic, anti-inflammatory[18], analgesic[18] effects of fennel are well known for centuries in folk medicine. The increasing commercial value of fennel in both National and International market necessitates its sustainable cultivation for increasing yield and value added products. With the view to it, the methodology of induced mutagenesis (EMS and γ-irradiations) has been adopted. Screened macromutant plant types are analyzed at M_6 generation in relation to control to detect significant variations, if any, aiding to efficient breeding and crop improvement relating to yield and bioactive compounds.

MATERIAL AND METHODS

Phenotypic mutations were induced following exposure of dry seeds (moisture content – 9.3%) to γ-irradiations (20, 40, 80 and 100 Gy) and EMS (0.25%, 0.50% and 1.0%; 2h and 4h) treatments. Seven macromutants (thick stem - TS, slender stem - SS, pigmented stem - PS, dwarf - Dw, elongated pinnae - EP, narrow pinnae - NP and early flowering - EF) were screened (total plants screened - 1575) at M_2 generation and after maintaining for five generations are compared to control (C) for yield and yield related traits (plant height, number of primary branches/plant, total branches/plant, number of compound umbels/plant, number of umbels/plant, number of umbellets of first inflorescence, seed yield and harvest index) in M_6 generation. The plant types are grown in randomized block design in 3 replications (spacing of 25 cm between lines and 10 cm between plants).

Five plants are randomly selected from each replication and a total of 15 plants are assessed for each plant type. Duncan's test[19] is computed (5% level of significance) for each parameter to assess significant variation between/among the plant types. Homogenous treatment means are assessed following Duncan's test. Alphabets are used corresponding to each mean to denote the magnitude of performance of each trait in each plant type; the alphabets are arranged in descending order to indicate the gradation of superiority. Similar alphabets represent homogenous plant types and the more the common alphabets in the plant types, the less the non-significant differences between them.

RESULTS AND DISCUSSION

Results indicate (Table 1) that there are significant variations among plant types for the traits excepting number of primary branches per plant. Thick stem mutant shows significant enhancement in number of umbellets of the first formed inflorescence than control. In this mutant type total branches/plant, number of compound umbels/plant, number of umbels/plant and seed yield also exhibit superiority over control. Elongated pinnae mutant also manifests betterment in plant height trait than control. From the results obtained it can be inferred that none of the mutants have exhibited superiority over respective control for all the traits under study but a few of them have shown betterment in some traits.

Research aiming to improvement through induced mutagenesis is rare in seed spices. Ramkrishna[20] using gamma irradiations and chemical mutagens (EMS and Sodium Azide) developed some superior M_2 progenies in fennel with higher yield than control; Mostafa and Abou Alhamd[21] produced two superior mutants than control in respect of salt tolerance using dimethyl sulphate (DMS). In the present investigation among the entire mutants thick stem mutant is the most promising plant type in comparison to control and offer scope of direct selection; while, breeding endeavor followed by selection may be recommended for the rest plant types.

Figure 1: a. Control (stem diameter at base – 5 mm), b. Thick stem mutant (diameter – 11 mm)

Table 1: Mean of eight parameters in control and macromutants of fennel

Quantitative traits	Plant types							
	C	TS	SS	PS	Dw	EP	NP	EF
Plant height (cm)	84.0 ab ± 2.7	87.7 ab ± 6.6	64.0 cd ± 2.9	51.2 de ± 1.2	44.5 e ± 1.0	96.0 a ± 6.7	56.4 de ± 3.1	73.3 bc ± 5.0
*No. of primary branches/plant	6.4 ± 0.4	6.0 ± 1.0	5.5 ± 0.3	5.0 ± 0.6	5.7 ± 1.5	5.3 ± 0.3	5.4 ± 0.2	4.7 ± 0.3
Total branches/plant	25.4 ab ± 2.5	32.7 a ± 13.0	19.0 bc ± 2.4	11.3 c ± 0.7	17.0 bc ± 5.5	25.5 ab ± 3.5	15.2 bc ± 0.6	18.2 bc ± 2.2
No. of compound umbels/plant	22.6 ab ± 3.0	25.3 a ± 9.4	17.0 abc ± 2.5	10.0 c ± 0.6	13.0 bc ± 4.4	16.3 abc ± 2.4	12.6 bc ± 1.2	13.5 bc ± 1.8
No. of umbels/plant	154.8 ab ± 19.1	203.0 a ± 74.2	86.8 bc ± 11.6	48.0 c ± 1.5	63.0 c ± 20.1	144.3 ab ± 12.0	66.2 c ± 7.9	108.3 bc ± 13.5
No. of umbellets of first inflorescence	27.4 b ± 6.8	83.3 a ± 18.3	25.0 b ± 4.7	37.7 b ± 4.7	30.7 b ± 10.2	47.5 b ± 9.9	28.2 b ± 5.2	38.3 b ± 5.3
Seed yield (gm)	2.17 ab ± 0.5	2.29 a ± 0.9	1.02 bcd ± 0.1	0.90 cd ± 0.01	0.24 d ± 0.1	1.62 abc ± 0.4	0.74 cd ± 0.1	1.22 abcd ± 0.2
Harvest index (%)	29.3 a ± 1.7	18.3 ab ± 6.2	20.4 ab ± 1.1	24.0 ab ± 0.2	11.4 b ± 4.2	18.4 ab ± 3.8	19.5 ab ± 2.3	21.5 ab ± 3.8

C- control, TS- thick stem, SS- slender stem, PS- pigmented stem, Dw- dwarf, EP- elongated pinnae, NP- narrow pinnae and EF- early flowering.
*non-significant variations among the plant types.

CONCLUSION

The aim to raise desirable plant type mutants through induced mutagenesis has been accomplished to some extent in this spice. The *thick stem* mutant evolved seems to be in the direction of the objective underlined and corresponds closely with the ideotype been looked for in the crops. This plant type can be selected for further efficient breeding programme.

REFERENCES

1. Piccaglia R, Marotti M. Characterization of Some Italian Types of Wild Fennel (*Foeniculum vulgare* Mill.) J Agric Food Chem 2001; 49:239-44.
2. Faudale M, Viladomat F, Bastida J, Poli F, Codina C. Antioxidant activity and phenolic composition of wild, edible and medicinal fennel from different Mediterranean countries. J Agric Food Chem 2008; 56(6):1912–20.

3. Oktay M, G¨ulc¸in I, K¨ufrevioglu OI. Determination of in vitro antioxidant activity of fennel (*Foeniculum vulgare*) seed extracts. LWT- Food Sci Technol 2003; 36(2):263-71.
4. Anwar F, Ali M, Hussain AI, Shahid M. Antioxidant and antimicrobial activities of essential oil and extracts of fennel (*Foeniculum vulgare* Mill.) seeds from Pakistan. Flavour Frag J 2009; 24(4):170–6.
5. Shahat AA, Ibrahim AY, Hendawy SF, Omer EA, Hammouda FM, Abdel-Rahman FH *et al*. Chemical composition, antimicrobial and antioxidant activities of essential oils from organically cultivated fennel cultivars. Molecules 2011; 16:1366- 77.
6. Singh G, Maurya S, de Lampasona MP, Catalan C. Chemical constituents, antifungal and antioxidative potential of *Foeniculum vulgare* volatile oil and its acetone extract. Food Control 2006; 17:745–52.
7. Gulfraz M, Mehmood S, Minhas N, Jabeen N, Kausar R, Jabeen K *et al*. Composition and antimicrobial properties of essential oil of *Foeniculum vulgare*. African J Biotechnol 2008; 7(24):4364-8.
8. Abed KF. Antimicrobial activity of essential oils of some medicinal plants from Saudi Arabia. Saudi J Biol Sci 2007; 14:53–60.
9. Mohsenzadeh M. Evaluation of antibacterial activity of selected Iranian essential oils against *Staphylococcus aureus* and *Escherichia coli* in nutrient broth medium. Pak J Biol Sci 2007; 10:3693–7.
10. Saini N, Singh G.K., Nagori B.P. Spasmolytic potential of some medicinal plants belonging to family Umbelliferae: A review. Int. J. Res. Ayurveda Pharm. 2014;5(1):74-83 http://dx.doi.org/10.7897/2277-4343.05116
11. Anand P, Kunnumakara A, Sundaram C, Harikumar K, Tharakan S, Lai O *et al*. Cancer is a preventable disease that requires major lifestyle changes. Pharmaceut Res 2008; 25:2097-116.
12. Pradhan M, Sribhuwaneswari S, Karthikeyan D, Minz S, Sure P, Chandu AN *et al.* In-vitro cytoprotection activity of *Foeniculum vulgare and Helicteres isora* in cultured human blood lymphocytes and antitumour activity against B16F10 melanoma cell line. Res J Pharm Technol 2008; 1(4):450-2.
13. Mohamad RH, El-Bastawesy AM, Abdel-Monem MG, Noor AM, Al-Mehdar HAR, Sharawy SM *et al.* Antioxidant and Anticarcinogenic Effects of Methanolic Extract and Volatile Oil of Fennel Seeds (*Foeniculum vulgare*). J Med Food 2011; 14(9):986-1001.
14. El-Soud NA, El-Laithy N, El-Saeed G, Wahby MS, Khalil M, Morsy F *et al*. Antidiabetic activities of *Foeniculum vulgare* Mill. essential oil in streptozotocin-induced diabetic rats. Macedonian J Med Sci 2011; 4(2):139-46.
15. Tognolini M, Ballabeni V, Bertoni S, Bruni R, Impicciatore M, Barocelli E. Protective effect of *Foeniculum vulgare* essential oil and anethole in an experimental model of thrombosis. Pharmacol Res 2007; 56:254-60.
16. Özbek H, Uğraş S, Dülger H, Bayram I, Tuncer I, Öztürk G *et al*. Hepatoprotective effect of *Foeniculum vulgare* essential oil. Fitoterapia 2003; 74(3):317–9.
17. Koppula S, Kumar H. *Foeniculum vulgare* Mill. (Umbelliferae) attenuates stress and improves memory in wister rats. Trop J Pharm Res 2013; 12(4):553-8.
18. Choi E, Hwang J. Antiinflammatory analgesic and antioxidant activities of the fruit of *Foeniculum vulgare*. Fitoterapia 2004; 75:557-65.
19. Duncan DB. Multiple range and multiple F tests. Biometrics 1955; II:1-42.
20. Ramkrishna K. Mutation breeding in seed spices. Proc. of Int. symp. on induced mutations in plants (ISIM). Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture, Vienna (Austria) 2008; p.167.
21. Mostafa GG, Abou Alhamd MF. Induction of Salt Tolerant Mutants of *Foeniculum vulgare* by Dimethyl Sulphate and Their Identification Using Protein Pattern and ISSR Markers. Alex J Agric Res 2015; 60(2):95-109.

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