Biochemical studies on some aromatic plants as affected by gamma radiation and some energetic agents

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The investigation in this study was conducted through the main successive seasons (2003/2004 and 2004/2005) under the conditions of newly reclaimed soil at Inshas (Sharkia). The investigation was performed in the Experimental Field of Plant Research Department, Nuclear Research Center, Atomic Energy Authority at Inshas.The present study aimed to spot the light on the role of gamma radiation and some energetic components (Adenosine triphosphate (ATP), kinetin and tryptophan) on the physiological and biochemical characteristics of the two plant species of Umbelliferae, Foeniculum vulgare Mill and Carum carvi L. (fennel and caraway), plants. The study aims to get use of the positive effects of theses substances to improve the growth, yield and active ingredients of these plants.Fennel and caraway seeds were irradiated before sowing with gamma rays at 0, 40, 80, 120 and 160 Gy. The plants were grown in the field and subjected to the foliar spray of ATP, kinetin. and tryptophan at concentrations of 15, 30 and 45 and 20, 40 and 60 and 40, 60 and 80 p.p.m respectively .Effect of gamma irradiation, foliar application of ATP, kinetin and tryptophan and their combinations on plant growth, leaf chlorophyll content, nutritional status of plants, seed, oil yield and oil component were studied.The obtained results could be summarized as follows: 5. 1. Growth Characters:5.1.1.Effect of gamma radiation and foliar application of ATP:Using low gamma doses (40- 160 Gy) and foliar spray of ATP at concentrations of 15, 30 and 45 p.p.m was markedly and significantly promoting to plant growth parameters as fresh and dry weight of fennel and caraway plants. Moreover, the highest increase in these parameters of growth were obtained by the gamma rays at 80 Gy and ATP at 45 p.p.m .5.1.2. Effect of gamma radiation and foliar application of kinetin:The combined treatments of gamma radiation and kinetin at all doses and concentrations recorded the higher value in fresh and dry weight of fennel and caraway shoots. The best results were obtained by the combined treatment of 80 Gy x 60 p.p.m kinetin.5.1.3. Effect of gamma radiation and foliar application of tryptophan:Combination between gamma radiation and tryptophan had significant effect on fresh and dry weight of fennel and caraway plants compared with control plants. The highest value was obtained by the combined treatment of 80 Gy x 80 p.p.m tryptophan.5.2. Chlorophyll content:5.2.1. Effect of gamma radiation and foliar application of ATP:Chlorophyll content in leaves of fennel and caraway plants (a , b or both) showed increment as a result of all treatments under investigation , but the more effective treatment was obtained by the combined treatment of 80 Gy x 45 p.p.m ATP .5.2.3. Effect of gamma radiation and foliar application of kinetin:The combined treatment of gamma radiation and kinetin at all doses and concentrations had significant effect in increasing chlorophyll content of fennel and caraway leaves. The best result was obtained by the combined treatment of 80 Gy x 60 p.p.m kinetin.5.2.4. Effect of gamma radiation and foliar application of tryptophan:The combination between gamma radiation and tryptophan significantly increase chlorophyll content of fennel and caraway leaves. The best result was obtained by combined treatment of 80 Gy x 80 p.p.m tryptophan.5.3. Volatile oil Production:5.3.1. Volatile oil percentage and content (cc / plant):5.3.1.1. Effect of gamma radiation and of foliar application of ATP :Combination between gamma radiation doses and foliar application of ATP had no significant effect on the volatile oil percentage and content of fennel and caraway

seeds.5.3.1.1.2. Effect of gamma radiation and foliar application of kinetin:Combination between gamma radiation doses and foliar application of kinetin had a significant effect on the volatile oil percentage and content of fennel and caraway seeds. Combined treatment of 80 Gy x 60 p.p.m kinetin gave the best results in increasing the oil % of the two plants.5.3.1.1.4. Effect gamma radiation and foliar application of tryptophan:There was significant increase in oil % of the two plants as a result of the combined effect of gamma ray and foliar application of tryptophan treatment. The best result was obtained by the combined treatment of 80 Gy x 80 p.p.m tryptophan.5.3.2. Volatile oil yield (Kg / fed):5.3.2.1. Effect of gamma radiation and foliar application of ATP:There were slight increase in volatile oil yield (Kg / fed) of fennel and caraway seeds due to combination of low doses of gamma irradiation and high concentration of ATP. The bestresult was obtained with combination of 80 Gy x 45 p.p.m ATP. Yield of seeds volatile oil (L. /fed.) was positively related to seed yield (Kg / fed.).5.3.2.2. Effect of gamma radiation and and foliar application of kinetin:Combination between gamma radiation doses and foliar application of kinetin had a significant effect on the volatile oil yield (Kg / fed) of fennel and caraway seeds. Combined treatment of 80 Gy x 60 p.p.m kinetin gave the best result.5.3.2.3. Effect of gamma radiation and foliar application of tryptophan :There was a significant increase in oil yield (Kg/fed) of the two plants as a results of combined effect of gamma ray and foliar application of tryptophan treatment. The best result was obtained by the combined treatment of 80 Gy x 80 p.p.m tryptophan.5.3.3. G.L.C. of fennel and caraway volatile oils:Fennel and caraway volatile oils were analyzed by G.L.C. The oils of the two plants contained 11 compounds (2 unknown) and the rest (9) are known. Fennel volatile oil constituents were; a -Pinene, Fenchone, Limonene, Methyl chavicol, t-Anethole, Carvone, Cis-Anethole, Anise aldehyde and P-Anisic acid. a -Pinene, 13 - Pinene, Myrecene, Limonene, Thujone, P- cymene, Carvone, Dihydrocarveol and Trans-carveol for caraway plants. Trans-Anethole and Limonene consider the main components of fennel volatile oil. Carvone and Limonene were the main components of caraway volatile oil. The data showed that there were no effect of the combination of gamma radiation and foliarapplication of ATP, kinetin and tryptophan on the chemical constituents of fennel and caraway volatile oil except some increase or decrease in percentage of some components.5.4. Fruit Yield:5.4.1. Effect of gamma radiation and foliar application of ATP:Fruit yield of fennel and caraway plants (either as g /plant or as Kg/fed), was significantly increased by the combination of gamma rays and foliar application of ATP. The maximum yield of seeds was produced by the combined treatment of 80 Gy x 45 p.p.m ATP .5.4.2. Effect gamma radiation and foliar application of kinetin:Combination of gamma radiation doses and foliar application of kinetin had significant effect on the seed yield, (either as g/plant or as Kg/fed) of fennel and caraway seeds. Combined treatment of 80 Gy x 60 p.p.m kinetin gave the best result in increasing the seed yield of the two plants.5.4.3. Effect of gamma radiation and foliar application of tryptophanThere was significant increase in the seed yield, (either as g/plant or as Kg/fed), of the two plants as a results of combined effect of gamma ray and foliar application of tryptophan treatments. The best result was obtained by combined treatment of 80 Gy x 80 p.p.m tryptophan for the two plants.5.5. Nutrient content:5.5.1. Effect of gamma radiation and foliar application of ATP:1-Nitrogen percent and total protein content in fennel and caraway shoots were significantly increased by combination of gamma rays and foliar application of ATP. Furthermore, the highest N % was obtained by the combined treatment of ”80 Gy x 45 p.p.m ATP ”.2-Phosphorus percent of fennel and caraway shoots was increased by combination of gamma radiation doses and foliar application of ATP whereas this increase of P percentage did not reach significant level comparing to control. The maximum concentration of P % of fennel and caraway shoots was obtained by the combined treatment of ”80 Gy x 45 p.p.m ATP ”.3-Combination of gamma radiation doses and foliar application of ATP significantly increased potassium percent of fennel and caraway shoots. The maximum concentration of potassium percent in fennel and caraway shoots was obtained by the combined treatment of ”80 Gy x 45 p.p.m ATP ”.5.5.2. Effect of gamma radiation and foliar application of kinetin:1- Nitrogen percent and total protein content of fennel and caraway shoots were significantly increased by combination of gamma rays and foliar application of kinetin. The highestN % was obtained by the combined treatment of ”80 Gy x 60 p.p.m kinetin ”.2-Phosphorus percent in fennel and caraway shoots was significantly increased by combination of gamma radiation doses and foliar application of kinetin. The maximum

concentration of P `)/0 in fennel and caraway shoots was obtained by the combined treatment of ”80 Gy x 60 p.p.m kinetin ”.3-Combination of gamma radiation doses and foliar application of kinetin significantly increased potassium percent of fennel and caraway shoots. The maximum concentration of K % in fennel and caraway shoots was obtained by the combined treatment of ”80 Gy x 60 p.p.m kinetin ”.5.5.3. Effect of gamma radiation and foliar application of trvptophan :1-Nitrogen percent and total protein content of fennel and caraway shoots were significantly increased by combination of gamma rays and foliar application of tryptophan. The highest N % was obtained by the combined treatment of 80 Gy x 80 p.p.m tryptophan2-Phosphorus percentage of fennel and caraway shoots was significantly increased by combination of gamma radiation doses and foliar application of tryptophan. The maximum concentration of P % in fennel and caraway shoots was obtained by the combined treatment of ”80 Gy x 80 p.p.m tryptophan ”.3-Combination of gamma radiation doses and foliar application of tryptophan significant increased potassium percentage infennel and caraway shoots. The maximum concentration of K in fennel and caraway shoots was obtained by the combined treatment of 80 Gy x 80 p.p.m tryptophan.5.6. Total carbohydrates content:5.6.1. Effect of gamma radiation and foliar application of ATP:Combination of gamma radiation doses and foliar application of ATP treatment induced a stimulation effect on total carbohydrates content of fennel and caraway shoots. The maximum value of total carbohydrates content was obtained by the combined treatment of 80 Gy x 45 p.p.m ATP ”.5.6.2. Effect of gamma radiation and foliar application of kinetin:Combination of gamma radiation doses and foliar application of kinetin treatment had significant effect on total carbohydrates content of fennel and caraway shoots. The maximum value of total carbohydrates content was: obtained by the combined treatment of ”80 Gy x 60 p.p.m kinetin ”.5.6.3. Effect of gamma radiation and foliar application of tryptophan:Combination of gamma radiation doses and foliar application of tryptophan treatment significantly increased total carbohydrates content of fennel and caraway shoots. The maximum value of total carbohydrates content was obtained by the combined treatment of 80 Gy x 80 p.p.m tryptophan ”.5.7. Total Sugars content:5.7.1. Effect of gamma radiation and foliar application of ATP:Combination of gamma radiation doses and foliar application of ATP Gamma radiation treatment induced a stimulation effect on total sugars content (reducing and non-reducing) of fennel and caraway shoots. The maximum value oftotal sugars was obtained by the combined treatment of ”80 Gy x 45 p.p.m ATP ”.5.7.2. Effect of gamma radiation and foliar application of kinetin:Combination of gamma radiation doses and foliar application of kinetin treatment had a significant effect on total sugars content (reducing and non-reducing) of fennel and caraway shoots. The maximum value of total carbohydratescontent was obtained by the combined treatment of 80 Gy x 60 p.p.m kinetin ”.5.7.3. Effect of gamma radiation and foliar application of trvptophan :Combination of gamma radiation doses and foliar application of tryptophan treatment significantly increased total sugars content (reducing and non-reducing) of fennel and caraway shoots. The maximum value of total carbohydratescontent was obtained by the combined treatment of ”80 Gy x 80 p.p.m tryptophan ”.5.8. Antioxidant activity of fennel and caraway volatile oilFennel and caraway volatile oils had antioxidant activity on sunflower oil comparing with the synthetic antioxidant (BHT).The results cleared that the two oils had antioxidant activity and the effect was increased by increasing the volatile oils concentrations. Also, the data revealed that fennel volatile oil has more antioxidant activity than caraway volatile oil.The results indicate that fennel and caraway volatile oils have antioxidant activity greater than the synthetic antioxidant BHT.CONCLUSION:Combination of gamma irradiation and foliar application of ATP, kinetin and tryptophan increase the vegetative growth, seed yield and the volatile oil content of fennel and caraway plants.The best combination doses were 80Gy x 45 p.p.m ATP, 80 Gy x 60 p.p.m kinetin and 80 Gy x 80 p.p.m tryptophan.Fennel and caraway volatile oils could be used as natural antioxidant materials.