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Effect of Gibberellic Acidon Seed Quality Parameters of Fennel (*Foeniculum vulgare* Mill.)

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ABSTRACT: *The experiment was conducted during winter season of 2012-13 at Research Farm of the Department of Vegetable Science, CCS Haryana Agricultural University, Hisar. In the present experiment, four different gibberellic acid concentrations including control (0, 50, 75 and 100 ppm) were sprayed at three different stages of crop growth (juvenile, flowering and initial seed setting stage). Twelve treatment combinations laid out in Randomized Block Design (factorial) were replicated thrice making total of 36 plots.Gibberellic acid application showed significant improvement in all the seed quality parameters over control. The best results forgermination percentage, seed vigour indices and test weight were recorded with the application of gibberellic acid at 100 ppm concentration.Stages of application of gibberellic acid had a significant effect on all seed quality parameters except seed vigour index- II.The maximum values for germination percentage, seed vigour index-I and test weight were observed with the gibberellic acid application at flowering stage. However, highest value of seed vigour index-II observed with the gibberellic acid application at juvenile stage.The best result for quality parameters with interaction effect was observed with the interaction of gibberellic acid 100 ppm applied at flowering stage.*

Keywords*: randomized block design, gibberellic acid, juvenile stage, harvest index*

INTRODUCTION

Fennel is an aromatic annual herb (biennial with potency of regeneration), which belongs to the family Apiaceae and generally grown in winter season in India. Dried seeds are the edible and economic part of plant with its numerous medicinal and aromatic properties due to its estrogenic activities and are used as a diuretic,carminative, antimicrobial and anti-inflammatory drug. In India, the seeds are masticated and chewed alone or with betel leaves after meal.The volatile oil of fennel is used to control flatulent dyspepsia and colic in children and for the manufacturing of cordials and fennel water, which is commonly given to infants as medicine. Fennel is widely cultivated throughout the temperate and sub-tropical regions of the world. In India, it is mainly cultivated in Gujarat, Rajasthan, Uttar Pradesh, Madhya Pradesh, Karnataka, Haryana and Punjab. India exports substantial quantity of fennel to USA, Singapore, UK, UAE, Sri Lanka, Malaysia, Saudi Arabia and Japan in a variety of forms including seed, powder, and volatile oils.

Quality seed is the basic input for growing of fennel or any other crop because this enhances the productivity by 15-20% [Sindhawani, 1991 [1]]. Quality seed denotes high genetical and physical purity, high vigour, high germination percentage and uniformity in appearance. The seed vigour as a quality attribute has gained wide significance as it determines the performance potential of a seed under varying field conditions. The advantages of high quality seed are most often associated with rapid and high rate of emergence and field establishment.

Agricultural research, until now, has been primarily concerned with enhancing seed quality by the use of seed treatment techniques, seed treatment chemicals or additives, better management coupled with variety development and genetic improvements. Little attention has been given to regulation of the biological processes of plant that limits seed quality and vigour. It has been observed that synthesis and translocation of photosynthates into sink is very poor at later stages of the crop, besides poor vegetative growth and flowering.

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Growth hormones play an important role as the small quantities regulate the various physiological processes and balance the source and sink thereby enhancing the seed vigour.Gibberellic acid is found to be one of the most important means to increase seed quality in many of the seed spices like fenugreek, coriander and cumin. In spite of its great economic importance and export value, little research has been carried out on the application of growth regulators for obtaining good seed quality. Keeping in view the above facts, this experiment has been planned with the objective to find out appropriate concentration of gibberellic acid and perfect stage of plant for its applicationfor getting seed with quality and high vigour in fennel crop.

MATERIAL AND METHODS

The experiment was carried out at Vegetable Research Farm, Department of Vegetable Science, CCS Haryana Agricultural University, Hisar during winter season of 2012-13. Hisar is situated at the latitude of 29°.10¢N, longitude of 75°.46¢E and at a mean altitude of 215.2 meters above sea level. This place is characterized by hot and dry summer (April to June) followed by a hot and humid monsoon period and cold winters during December-January.

Soil analysis revealed that the soil of the experimental field was sandy loam in texture, slightly saline (pH=8.18), medium in organic carbon content (0.44%), low in available nitrogen (140 kg/ha), high in available phosphorus (21.0 kg/ha) and rich in potassium content (486.0 kg/ha).

The experiment was laid out in Randomized Block Design (factorial) replicated thrice with four different gibberellic acid concentrations as main plot treatments i.e. Control or no spray (C_1),50 ppm (C_2), 75 ppm (C_3) and 100 ppm (C_4) and three different application stages [Juvenile stage (S_1), Flowering stage (S_2), Initial seed setting stage (S_3)] as sub-plot treatments, thus making a total of twelve treatment combination (C_1S_1, C_2S_1, C_3S_1, C_4S_1, C_1S_2, C_2S_2, C_3S_2, C_4S_2, C_1S_3, C_2S_3, C_3S_3, C_4S_3)in a plot size of 3.0 m × 2.4 m = 7.2 m^2 for each replication. A spacing of 30cm × 20 cm was maintained between line-to-line and plant-to-plant.

The seed material used for the present investigation was a local genotype HF-33 (Hisar Swarup) which was procured from the Department of Vegetable Science, CCS Haryana Agricultural University, Hisar, Haryana. For prepration of gibberelic acid solution, required amount of gibberellic acid (50 milligram for 50 ppm solution, 75 milligram for 75 ppm solution, 100 milligram for 100 ppm solution) was dissolved in one litre of water, but while preparing the solution, gibberellic acid was first dissolved in two to three drops of alcohol as gibberellic acid cannot be dissolved directly in water.

Mean values of different seed quality test data were used for statistical analysis. Various observations recorded were seedtest weight (g), germination percentage, seed vigour indices- I & II.For analysis of test weight (g), mean weight of three replicates of 1000healthy seeds of each treatment was recorded in grams up to two decimal places.

For standard germination percentage of seeds, a total of hundred seed per replication for each treatment were placed seperatly between two layers of moist germination paper (BP) and then kept in seed germinator at 20^0C. The final count of normal seedlings was made on the 21st day and expressed as percent germination.

The seedling length was measured on ten randomly selected normal seedlings taken from three replications of standard germination test and recorded in centimeter. The average of ten seedlings was taken for final calculation.

For measuring of dry weight per seedling (mg) ten normal seedlings selected for measuring seedling length were further kept in hot air oven for taking dry weight. These are dried at 80^0C for 48 h and then seedling dry weight was recorded in milligram. The average weight of ten seedlings was taken for further calculation.

The vigour indices were calculated according to the following formulae [Abdul Baki and Anderson, 1973 [2]].

Vigour Index- I: Standard germination (%) x Seedling length (cm)

Vigour Index- II: Standard germination (%) x Seedling dry weight (mg)

The data to be recorded for various parameters during the course of investigation will be subjected to statistical analysis by using the techniques of analysis of variance (ANOVA) as suggested by Panse and Sukhatme (1967) [3]. The significance of treatment effects will be judged using F test.

RESULTS

Data presented in Table-1 indicates thattest weight (g), germination percentage (%) and seed vigour index- Iwere significantly influenced by bothvarious concentration of gibberellic acidand stage of plant

Table 1
Effect of Gibberellic Acid on Seed Quality Parameters of Fennel

GA_3 Concentration	*Recorded Observations and Stages of GA_3 application (S_1, S_2 S_3)*															
	Test weight (g)				*Standard seed germination (%)*				*Seed vigour index- I*				*Seed vigour index- II*			
	S_1	S_2	S_3	*Mean*	S_1	S_2	S_3	*Mean*	S_1	S_2	S_3	*Mean*	S_1	S_2	S_3	*Mean*
C_1 Control (no spray)	7.96	6.93	7.46	7.45	72.33	70.33	71.33	71.33	1139.3	1143.4	1259.5	1180.7	0.58	0.28	0.36	0.40
C_2 50 ppm	7.73	8.40	7.40	7.84	72.00	75.00	72.66	73.22	1390.3	1386.2	1359.5	1378.7	0.36	0.44	0.59	0.46
C_3 75 ppm	8.03	8.76	8.20	8.33	70.66	86.00	82.66	79.77	1391.4	1730.2	1683.7	1593.8	0.63	0.48	0.62	0.58
C_4 100 ppm	9.56	9.63	8.76	9.32	77.33	86.33	84.67	82.66	1460.7	1781.2	1589.9	1681.7	0.63	0.61	0.57	0.60
Mean	8.32	8.43	7.95		73.08	79.41	77.75		1345.4	1510.2	1473.1		0.55	0.49	0.54	
C.D. (P=0.05)	GA_3 Concentrations: 0.11 Application stages: 0.10 GA_3 Concen. × Application stages: 0.20				GA_3 Concentrations: 1.88 Planting methods: 1.63 GA_3 Concen. × Application stages: 3.20				GA_3 Concentrations:3.8 Planting methods: 3.3 GA_3 Concen. × Application stages:6.6				GA_3 Concentrations:0.04 Planting methods: N.S. GA_3 Concen. × Application stages:0.07			

for its application. However, seed vigour index- II showed a non-significant variation for stages of application.

It is revealed from the data recorded for various observations that test weight (g), germination percentage (%) and seed vigour index- I weremaximum with the application of 100 ppm gibberellic acid (C_4) at flowering stage of plant (S_2) i.e. $C4S_2$. While, seed vigour index- II was maximum with application of 75 or 100 ppm gibberellic acid concentration (C_3 or C_4) at juvenile stage of plant (S_1) i.e. C_3S_1 or C_4S_1.

DISCUSSION

In view of the literature information available, the result presented in the Table-1 is discussed here as under. The findings revealed significant variation for test weight among different gibberellic acid concentrations and the best result was noticed with GA_3 at 100 ppm concentration. Among different stages of application, the foliar spray of gibberellic acid at flowering stage showed the best result for test weight. Interaction also showed remarkable variation among different treatment combinations but gibberellic acid at 100 ppm concentration applied as foliar spray at flowering stage was found to be the best. Similar results were reported by Singh *et al.* (2012) [4] in coriander, Pariari *et al.*, 2012 [5] in black cumin, Panda *et al.* (2007) [6] and Purbey and Sen (2005) [7], who observed GA_3 at 100 ppm as the best concentration with respect to test weight in coriander and fenugreek, respectively. The results also support the findings of Shah and Pillai (1969) [8], who reported increased test weight in cumin with the application of gibberellic acid. Present results might be due to enhanced physiological activities like photosynthesis and translocation of nutrients and photosynthates (Saxena, 1989) [9].

Germination percentage increased with the increase in gibberellic acid concentration from 0 to 100 ppm and GA_3 at 100 ppm concentration gave the best result. Among different stages of gibberellic acid application, foliar spray at flowering stage gave the best result with respect to germination percentage. The interaction effect between gibberellic acid concentrations and stages of application showed that application of 100 ppm gibberellic acid at flowering stage gave the best result with respect to germination percentage.The results confirm the findings of Tsakalidi *et al.* (2011) [10] in coriander, dill and aniseed, Banafar (1994) [11] who found increased germination and emergence of coriander seeds with 100 ppm gibberellic acid. Increased germination percentage might be attributed to the induction of synthesis of *á*-amylase, protease and other hydrolytic enzymes by the applied gibberellic acid. Gibberellic acid also appears to induce the activity of gluconeogenic enzymes during early stages of seed germination (Pandey and Sinha, 1995) [12].

The seed vigour index of fennel increased considerably among different treatments. Seed vigour index increased significantly with increased concentration of applied gibberellic acid but the best result was noticed with gibberellic acid application at 100 ppm concentration. The results revealed that application of gibberellic acid at flowering stage showed the best result with respect to seed vigour index. Interaction of GA_3 at 100 ppm concentration applied as foliar spray at flowering stage showed the best result. The results are in accordance with the findings of Dhungel *et al.* (2007) [13] who reported significant increase in vigour index of chilli with the application of gibberellic acid. Similar results were also observed by Tirakannanavar *et al.* (2007) [14] in bittergourd. The improvement in vigour index might

be attributed to improved germination, which was due to stimulation of enzymatic activities. This might also be due to good seedling growth caused by improved mobilization of food reserves.

CONCLUSION

Based on the experimental results, it can be concluded that application of gibberellic acid improved the quality and vigour attributes of fennel seed. 100 ppm was the optimum concentration and flowering stage was the right stage for gibberellic acid application to improve the quality and vigour of fennel seed.

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