

## Original Research Article

# EFFECT OF SOWING DENSITY SEED RATE AND SOWING METHOD ON SEED YIELD OF FENNEL

### Abstract

The research was ~~conducted~~ ~~carried out~~ at the research field of Spices Research Sub-Centre, Faridpur during Rabi season, 2017-18 and 2018-19 to determine the optimum seed rate and suitable sowing method for Fennel cultivation. The experimental field belongs to high land of Lower Gangetic River Floodplain (AEZ 12) with clay loam ~~in~~ texture having 7.6-8.1 soil p<sup>H</sup>. The experiment was laid out in a Randomized (~~factorial~~) Complete Block Design (~~factorial~~) with three replications. Four different seed rates ~~viz., i.e.~~ 6, 8, 10 and 12 kg seed/ha and two sowing methods ~~viz., i.e.~~ Broadcasting ~~sowing~~ and ~~row-Line~~ sowing ~~method~~ were evaluated. The highest ~~seed~~ yield (1569 kg/ha) was recorded ~~with~~ ~~from the treatment~~ combination of 10 kg seed/ha × ~~Broadcastline sowing~~ method. The lowest seed yield (985.8 kg/ha) was recorded from 6 kg seed/ha × Broadcasting ~~sowing~~ method.

*Key words:* Plant population, Sowing method, Crop Cultural management, Fennel cultivation

### Introduction

Fennel (*Foeniculum vulgare*) ~~which~~ belongs to ~~the family~~ Apiaceae or Umbelliferae ~~family~~, is a ~~highly strong~~ aromatic biennial perennial ~~plant~~. ~~Grown throughout the Cultivated~~ world, ~~it has been widely wide and extensively~~ used ~~in as a~~ traditional medicine since ancient times. It is also ~~used utilized for~~ ~~the~~ flavouring of a number of food products and in cosmetics [1a & 1b]. Fennel has antifungal, antioxidant, antibacterial and mosquito repellent properties [2]. Fennel ~~treats~~ ~~causes~~ asthma ~~and~~ windy colic, ~~and is~~ useful ~~for~~ diseases of chest, spleen and kidneys [3]. ~~In addition,~~ Fennel ~~also~~ has carminative, aromatic flavoring, antioxidant, ~~antibacterial, antifungal antibacterial, antifungal~~ and mosquito repellent properties [4]. The fruits are used ~~to treat~~ flatulence, fever, intestinal colic, burning ~~sensation~~ and constipation. Farmers ~~throughout from all over~~ Bangladesh ~~are~~ growing fennel ~~crop~~ mainly for ~~their own~~ domestic uses. ~~The~~ product obtained from such a ~~small lesser~~ area is insufficient to meet the ~~country~~ commercial ~~needs, requirements of the country~~ and ~~cannot bridge~~ ~~unable to cover~~ the gap between demand and production. ~~So,~~ there is ~~therefore an urgent dire~~ need to increase ~~the~~ fennel production in Bangladesh. ~~Appropriate Proper~~ cultural ~~management~~ practices ~~are~~ needed to increase ~~the~~ seed yield of fennel. Therefore, the trial was designed to find out the ~~most best~~ ~~suitable~~ optimum ~~sowing~~ ~~seed~~ rate and sowing method affecting the growth, yield and yield components of fennel.

### Materials and Methods

The experiment was conducted at the research field of Spices Research Sub-Centre, Faridpur during Rabi season, 2017-18 and 2018-19 to determine the optimum seed rate and suitable sowing method for fennel cultivation. The experimental field belongs to high land of Low Gangetic River Floodplain (AEZ 12) with clay loam ~~in~~ texture having 7.6-8.1 soil p<sup>H</sup>. The experiment was ~~set up~~ ~~laid out~~ with a Randomized Complete ~~factorial-Block~~ Design (~~factorial~~) with three replications. Four seed rates (~~viz.~~ 6, 8, 10 and 12 kg/ha) and two sowing methods (~~viz.~~ ~~broadcasting~~ and ~~in~~ line ~~sowing method~~) were evaluated. BARI Mouri-1 was used as a test crop. The seeds were ~~sown~~ continuously ~~sown~~ on 09 November ~~in~~ 2017. The ~~single~~ plot size was 3m x 2m. Plant spacing was 40cm x 15cm. The land was fertilized with ~~cow dung~~ 5 tons ~~of cow dung~~, N<sub>80</sub> P<sub>35</sub> K<sub>70</sub> S<sub>20</sub> kg/ha. The ~~total entire~~ quantity of cow dung, P and K ~~was~~ ~~applied~~ during ~~the~~ final ~~land~~ preparation ~~of the land~~. Nitrogen was applied in two

**Comment [UW1]:** I missed the description of the subject, the main objective and the conclusion. I think you could revise the abstract

**Comment [UW2]:** You say that the production of fennel is insufficient in Bangladesh, how many tonnes are produced per year, how much land is planted, what difficulties are encountered in the production of fennel/You have to explain the problem and specify the main objective. I think the introduction is poor on the whole, you could improve it better through the bibliography review

**Comment [UW3]:** You should describe the study site with a map to support it, the rainfall, the amount of rain has an impact on the type of cultivation

equal parts, splits one at 15 days after germination and the other at flowering stage followed by irrigation. Four weeding were carried out done at 10, 25, 40 and 55 DAE. Four irrigations were carried out done at 15, 30, 45 and 60 DAE. A slight irrigation was carried out given three days after sowing to ensure optimum soil moisture for germination. Two spraying of Rovral 50wp @ 2g/L of water were applied at flowering and ripening maturity stage to prevent escape from Alternaria leaf and umbel blight disease. The crop was harvesting took place on 12 April, 2018. Data on the number of plants per m<sup>2</sup>, plant height (cm), number of primary branches per plant, number of umbels per plant, number of umbel lets per umbel, number of seeds per umbel let, 1000-seed weight (g) and seed yield (kg/ha) were recorded. The collected data collected were analyzed using by MSTAT-C statistical software package and the mean values were analyzed using by Duncan's Multiple Interval Range test.

## Results and Discussion

### Effect of seed rate

The different seed doses rates had significant effect on the number of plants per m<sup>2</sup>, the number of branches per plant, the number of umbels per plant, the number of umbel lets per umbel, the number of seeds per umbel let and seed yield (kg/ha) during 2016-17. But the plant height was not significant (Table-1). In 2017-18 and 2018-19 a higher number plants per m<sup>2</sup> (62.00) and (65.16) was recorded with from the seed rate of 12 kg/ha and at the lower number of plants per m<sup>2</sup> (49.33) and (51.83) was recorded with from the seed rate of 6 kg/ha. It was expected that plants grown densely grown plants were expected to be taller because they could not find enough space to spread [5].

**Comment [UW4]:** What explanation do you give for this? You should say, for example, that these results corroborate those of (5) who worked on... and this would be explained by...

On the other hand, In 2017-18 the highest number of umbels per plant (28.25), umbel lets per umbel (26.7) and number of seeds per umbel let (24.08) was recorded when 8kg/ha of seeds were sown respectively. The lowest number of umbels per plant (26.23), umbel leaves per umbel (22.4) and seeds per umbel let (21.82) was recorded with from the sowing density of seed rate 12 kg/ha. The highest seed yield (1,395kg/ha) was recorded at a sowing density of from the seed rate 12 kg/ha and the lowest seed yield (1140 kg/ha) at a sowing density of was recorded from the seed rate 6 kg/ha.

In 2018-19 the highest number of umbels per plant (31.28), umbel lets per umbel (30.83) and number of seeds per umbel let (27.48) were recorded when 8kg/ha seeds were sown respectively. The lowest number of umbels per plant (25.28), umbel leaves per umbel (24.70) and seeds per umbel let (24.73) was recorded with from the sowing density of seed rate 12 kg/ha. The highest seed yield (1,395kg/ha) was recorded at a sowing density of from the seed rate 12 kg/ha and the lowest seed yield (1,140 kg/ha) at a sowing density of was recorded from the seed rate 6 kg/ha.

Several researchers have revealed that the number of umbels per plant is affected by plant density that as and when plant density increases, the number of umbels number decrease [6a,6b & 6c].

**Comment [UW5]:** What explanation do you give for this?

**Table.1 Effect of seed rate on the yield and yield contributing characters of fennel during 2017-18**

Treatments	Plant height of plant (cm)	Number of Plants/ m <sup>2</sup>	Number of Branches/ plant	Number of Umbels/ plant	Number of Umbel lets/ Umbel	Number of Seeds/ Umbel let	1000 seed weight (g)	Yield (kg/ha)
6 kg/ha	146.6a	49.33c	8.367	27.00ab	23.78b	22.13b	4.10c	1140c
8 kg/ha	145.8a	51.50b	8.167	28.25a	26.73a	24.08a	4.71a	1161c
10 kg/ha	146.6a	59.83b	8.400	27.32ab	26.25ab	22.08b	4.70a	1266b

12 kg/ha	143.9a	62.00a	7.967	26.23b	22.48c	21.82b	4.50b	1395a
Level of sigf.	NS	**	*	**	**	**	*	**
CV (%)	7.74	5.08%	10.29	14.89	3.50	2.26	2.10	5.40

In a column, means followed by the same letter did not differ significantly.

NS = Non significant, \*\* = 1% level of significance. \* = 5% level of significance.

**Table.2 Effect of seed rate on the yield and yield contributing characters of fennel during 2018-19**

Treatments	Plant height of plant (cm)	Number of Plants/ m <sup>2</sup>	Number of Branches / plant	Number of Umbels/ plant	Number of Umbels/Umbel	Number of Seeds/ Umbel let	1000 seed weight. (g)	Yield (kg/ha)
6 kg/ha	161.4a	51.83d	9.583ab	27.83b	25.38bc	25.02b	4.10c	1140c
8 kg/ha	160.8a	53.66c	10.43a	31.28a	30.83a	27.48a	4.71a	1161c
10 kg/ha	161.6a	62.50b	9.767ab	27.68b	26.03b	24.73b	4.70a	1266b
12 kg/ha	159.0a	65.16ab	9.433ab	25.28c	24.70c	24.20b	4.50b	1395a
14 kg/ha	169.3a	73.83a	8.500b	23.92d	23.57d	22.20c		
Level of sigf.	NS	**	**	**	*	*	*	**
CV (%)	6.31	5.21	11.40	3.84	3.36	3.31	2.10	5.40

In a column, means followed by the same letter did not differ significantly.

NS = Non significant, \*\* = 1% level of significance. \* = 5% level of significance.

#### Effect of sowing method

Different sowing methods had significant effect on the number of plants per m<sup>2</sup>, the number of primary branches per plant, the number of umbels per plant, the number of umbel lets per umbel, the number of seeds per umbel let and seed yield (kg/ha). But the plant height was not significant (Table-2). In 2017-18 and 2018-19 the highest number of plants per m<sup>2</sup> (64.0) and (69.66) was recorded with the row from line sowing method. In 2017-18, the highest number of plants per m<sup>2</sup> (47.3) and (53.13) was recorded with the broadcasting method. In 2017-18 the highest number of plants per m<sup>2</sup> (69.66) was recorded with the line sowing method and the lowest number of plants per m<sup>2</sup> (53.13) was recorded with the broadcasting method.

In 2017-18 the highest number of umbels per plant (30.9) was recorded with the line sowing method. The highest number of umbel lets per umbel (26.5) and (26.26), number of seeds per umbel let (23.01) and (24.74) were recorded by the line sowing method in 2017-18 and 2018-19 respectively, while in 2018-19 the highest number of umbels per plant (27.02) was recorded by the broadcasting sowing method. In 2017-18 the lowest number of umbels per plant (23.4), number of umbel lets per umbel (23.05), number of seeds per umbel let (21.9) was observed with the broadcasting sowing method. The lowest number of umbel shoots lets per umbel (25.94) and number of seeds per umbel shoots let, (24.70) were recorded by the broadcasting method in 2018-19. In 2018-19 lower number of umbels per plant (27.02) was observed with the line sowing method. Sowing methods and plant spacing have a significant effect on the number of umbels per plant [7] and [8].

The highest seed yield (1398.7 kg/ha) was recorded with the line sowing method and the lowest seed yield (1082.3 kg/ha) was recorded with the broadcast sowing method. Ashiq & Shah have also reported a significant effect of sowing methods on fennel seed yield of fennel [9].

**Comment [UW6]:** What explanation do you give for this?

**Table 3 Effect of sowing methods on the yield and yield contributing characters of fennel during 2017-18**

Treatments	Plant Height of plant (cm)	Number of Plants/m <sup>2</sup>	Number No. of Branches/plant	Number No. of Umbels/plant	Number No. of Umbel lets/Umbel	Number No. of Seeds/Umbel let	1000 seed weight (g)	Yield (kg/ha)
Broadcasting	144	47.3b	8.35a	23.4b	23.05b	21.90a	4.35b	1082.3b
Line sowing	147.4	64.0a	8.10ab	30.9a	26.50a	23.01b	4.65a	1398.7a
Level of sigf.	NS	**	*	**	**	**	*	**
CV (%)	7.74	5.08	10.29	14.89	3.50	2.26	2.10	5.40

In a column, means followed by the same letter did not differ significantly.  
NS = Non significant, \*\* = 1% level of significance. \* = 5% level of significance.

**Table 4 Effect of sowing methods on the yield and yield contributing characters of fennel during 2018-19**

Treatments	Plant Height of plant (cm)	Number of Plants/m <sup>2</sup>	Number No. of Branches/plant	Number No. of Umbels/plant	Number No. of Umbel lets/Umbel	Number No. of Seeds/Umbel let	1000 seed weight (g)	Yield (kg/ha)
Broadcasting	160.6a	53.133b	9.76a	27.37a	25.94b	24.70a	4.35b	1082.3b
Line sowing	164.2a	69.667a	9.32ab	27.02ab	26.26a	24.74a	4.65a	1398.7a
Level of sig.	NS	**	**	**	*	*	*	**
CV (%)	6.31	5.21	11.40	3.84	3.36	3.31	2.10	5.40

In a column, means followed by the same letter did not differ significantly.  
NS = Non significant, \*\* = 1% level of significance. \* = 5% level of significance.

### Interaction effect

The interaction effect of seed rates and sowing methods had a significant effect on the number of plants per m<sup>2</sup>, the number of primary branches per plant, the number of umbels per plant, the number of umbel lets per umbel, the number of seeds per umbel let and seed yield (kg/ha). However, the plant height was not significant (Table-3). The highest number of plants per m<sup>2</sup> (71.00) and (70.33) was recorded when seeds were sown in rows with 12 kg seed/ha and the lowest number of plants per m<sup>2</sup> (42) and (44.0) was recorded from 6 kg seed/ha × line sowing in rows and 6 kg seed/ha × broadcasting method in 2017-18 and 2018-19 respectively. In 2017-18 and 2018-19, the highest number of branches per plant (9.467) and (10.47) was recorded with 8 kg seed/ha × line sowing method and the lowest number of branches (7.33) and (9.13) was counted from 12 kg seed/ha with broadcasting method. Different agricultural practices have affected differently on the branches per plant [10].

On the other hand, in both in 2017-18 and 2018-19 the highest number of umbels per plant (34.07) and (31.30) was obtained with line sowing method when the seed was with 6 kg seed/ha. The highest number of umbel lets per umbel (30.3) and (31.87) was recorded by the drill method from line sowing method when seeded with 8 kg seed/ha. In 2017-18 the lowest number of umbels per plant (20.47) and number of umbel lets per umbel (21.26) were recorded by the broadcasting sowing method when seeded with 12 kg seed/ha. In 2018-19 the lowest number of umbels per plant (24.07) and number of umbel lets per umbel (23.93) were recorded by the broadcast sowing method when seeded with 10 kg of seed/ha. In 2017-18 the highest

**Comment [UW7]:** you can't talk about interaction without the interaction table your software allows you to create the interaction table

number of seeds per umbel let (25.37) was obtained by the drill from line sowing method with 10 kg/ha of seed. The lowest number of seeds per umbel let (20.03) was obtained by the drill from line sowing method with 12 kg/ha of seed. In 2018-19 the highest number of seeds per umbel let (28.03) was obtained by the drill from line sowing method with 8 kg/ha of seed and the lowest number of seeds per umbel let (24.13) was obtained by the from broadcasting method with 12 kg/ha of seed.

The highest seed yield (1569kg/ha) was recorded with the from treatment combination of 10 kg seed/ha x drill treatment combination line sowing method. The lowest seed yield (985.8 kg/ha) was recorded with the from 6 kg seed/ha x broadcast sowing combination method, which was more or less identical to the 6 kg seed/ha x broadcast sowing combination (1006 kg/ha).

**Table 5 Effect of seed rate and sowing method on the yield and yield contributing characters of fennel during 2017-18**

Treatments		Plant height of plant (cm)	Number of Plants/ m <sup>2</sup>	Number of Branches/plant	Number of Umbels/plant	Number of Umbel lets/ Umbel	Number of Seeds/ Umbel let	1000 seed weight. (g)	Yield (kg/ha)
6 kg/ha	Broadcasting	147.7	42.00d	8.267ab	26.80abc	24.80c	22.40cd	4.00f	985.8e
	Line sowing	143.8	42.00d	7.800b	34.07a	27.46b	22.80bc	4.40d	1006e
8 kg/ha	Broadcasting	147.4	52.33c	9.467a	30.93ab	23.70c	23.57b	4.80b	1117de
	Line sowing	137.1	53.00c	7.867ab	32.00a	30.33a	23.60b	4.20e	1221cd
10 kg/ha	Broadcasting	145.4	56.67bc	8.46ab	27.20abc	22.76cd	21.87d	4.20e	1294bc
	Line sowing	147.8	61.00b	8.533ab	22.43c	25.03b	25.37a	5.03a	1569a
12 kg/ha	Broadcasting	145.7	67.33a	7.333b	20.47c	21.26de	20.60e	4.02c	1317bc
	Line sowing	150.7	71.00a	8.067ab	23.70bc	23.13d	20.03e	4.80b	1415b
Level of sigf.		NS	**	*	**	**	**	*	**
CV (%)		7.74	5.08	10.29	14.89	3.50	2.26	2.10	5.40

In a column, means followed by the same letter did not differ significantly.

NS = Non significant, \*\* = 1% level of significance. \* = 5% level of significance.

**Table 6. Effect of seed rate and sowing method on the yield and yield contributing characters of fennel during 2018-19**

Treatments		Plant height of plant (cm)	Number of Plants/ m <sup>2</sup>	Number of Branches/plant	Number of Umbels/plant	Number of Umbel lets/ Umbel	Number of Seeds/ Umbel let	1000 seed weight. (g)	Yield (kg/ha)
6 kg/ha	Broadcasting	162.7a	44.33g	9.33ab	26.57c	24.90de	24.27b	4.00f	985.8e
	Line sowing	158.8a	44.00g	10.40a	31.30a	29.80b	26.93a	4.40d	1006e
8 kg/ha	Broadcasting	162.3a	54.67f	10.00a	29.37b	27.30c	25.37b	4.80b	1117de
	Line sowing	152.5a	55.33f	10.47a	31.27a	31.87a	28.03a	4.20e	1221cd
10 kg/ha	Broadcasting	167.0a	63.33de	9.933ab	24.07de	23.93ef	24.73b	4.20e	1294bc
	Line sowing	160.1a	59.33ef	9.83ab	29.10b	25.87cd	25.30b	5.03a	1569a
12 kg/ha	Broadcasting	162.8a	67.33cd	9.13ab	25.57c-e	25.40de	24.13b	4.02c	1317bc
	Line sowing	161.1a	70.33bc	9.60ab	25.00c-e	24.00ef	24.10b	4.80b	1415b
14 kg/ha	Broadcasting	165.5a	75.00ab	8.86ab	26.00cd	24.77def	22.00c		
	Line sowing	171.6a	80.33a	7.86b	23.77e	23.20f	22.40c		
Level of sigf.		NS	**	**	**	**	*	*	**

CV (%)	6.31	5.88	11.40	3.84	3.36	3.31	2.10	5.40
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In a column, means followed by the same letter did not differ significantly.  
NS = Non significant, \*\* = 1% level of significance. \* = 5% level of significance.

**Table 7 Economic performance of different treatments on the yield of Fennel during 2017-2018**

Treatments		Seed yield (kg/ha)	Gross yield return (Tk./ha)	Total cost of cultivation cost (Tk./ha)	Net yield return (Tk./ha)	Benefit-cost-benefit ratio
6 kg/ha	Broadcasting	985.8	177444	86169	91275	2.05
	Line sowing	1006	181080	96509	84571	1.87
8 kg/ha	Broadcasting	1117	201060	86522	114538	2.32
	Line sowing	1221	219780	96862	122918	2.26
10 kg/ha	Broadcasting	1294	232920	86874	146046	2.68
	Line sowing	1569	282420	97214	185206	2.9
12 kg/ha	Broadcasting	1317	237060	87227	149833	2.53
	Line sowing	1415	254700	97567	157133	2.61

Urea-Tk.16/kg, TSP-Tk. 22/kg, MoP-Tk. 15/kg, Gypsum-Tk. 10/kg, Zinc sulphate-Tk. 100/kg, Boric acid-Tk. 100/kg, Labour-Tk. 220/man day, Irrigation-2000/ha/irrigation, Lease value-Tk. 20800/ha for 5 months, Seed-Tk 200/kg. Sale price-Tk. 180/kg seed

**Table 8. Economic performance of different treatments on the yield of Fennel during 2018-2019**

Treatments		Seed yield (kg/ha)	Gross yield return (Tk./ha)	Total cost of cultivation cost (Tk./ha)	Net yield return (Tk./ha)	Benefit-cost-benefit ratio
6 kg/ha	Broadcasting	985.8	177444	86169	91275	2.05
	Line sowing	1006	181080	96509	84571	1.87
8 kg/ha	Broadcasting	1117	201060	86522	114538	2.32
	Line sowing	1221	219780	96862	122918	2.26
10 kg/ha	Broadcasting	1294	232920	86874	146046	2.68
	Line sowing	1569	282420	97214	185206	2.9
12 kg/ha	Broadcasting	1317	237060	87227	149833	2.53
	Line sowing	1415	254700	97567	157133	2.61

Urea-Tk.16/kg, TSP-Tk. 22/kg, MoP-Tk. 15/kg, Gypsum-Tk. 10/kg, Zinc sulphate-Tk. 100/kg, Boric acid-Tk. 100/kg, Labour-Tk. 220/man day, Irrigation-2000/ha/irrigation, Lease value-Tk. 20800/ha for 5 months, Seed-Tk 200/kg. Sale price-Tk. 180/kg seed

## Conclusion

From the above discussion it can be concluded that, treatment combination of 10 kg seed/ha x line sowing method may be good for cultivation of fennel.

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**Comment [UW8]:** You need to revise your conclusion, it's too small and doesn't include all the stages of a conclusion.

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