EFFECT OF SHADE AND SOWING METHOD ON ERYNGIUM FOETIDUM PRODUCTION

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ABSTRACT

The experiment was conducted at two Regional Spices Research Stations at Gazipur and Magura during July 2012 to June 2014. Experiments were conducted following split plot design with six treatment of two factors of three different shades such as 1) Black mosquito net, 2) Cucurbit trellis and 3) Control (open) and two sowing methods such as i) line sowing with 10cm spacing and ii) Broadcasting were placed in the unit plot. The maximum number of harvested plants (655/m2) and fresh yield (28.52 t/ha) were obtained from broadcast sowing under nylon net shade at Joydebpur while line sowing without shade gave the minimum number of harvested plants (293/m2) and fresh plant yield (16.20 t/ha) at Magura. The maximum gross return (Tk. 4944.2 thousand/ha), net return (Tk. 4438.2 thousand/ha) and BCR (1099) was obtained from nylon net shade in broadcast sowing and these was lowest (Tk. 1586.4, 1196.3 thousands/ha and 4.07, respectively) came from line sowing under cucurbits trellis. Cultivation of Eryngium under cucurbits trellis gave early returns that better for fresh leaf production. Open sunlight is less costly but it is not suitable for quality leaf production. Broadcasting sowing under nylon net shade seems better for leaf production and profit.

1. INTRODUCTION

Eryngium foetidum also known as Eryngium, Bilatidhonia, Bangladeshia, culantro, cilantro, spiny coriander or long coriander is a high valued perennial aromatic herb belongs to the family Apiaceae (Umbelliferae). Cultivation and consumption is increasing rapidly throughout the world due its medicinal, nutritional, aromatic and economic value (Wong, 1994). In 1999, world production was 9000 Metric tons while in 2008 it raised to 500,000 Metric tons (Ekpong, 2008). Vietnam, Puerto-Rico, Syria, Mexico, Srilanka, India and Bangladesh exporting Eryngium to the ethnic markets of UK, Canada, USA and Middle East. At present the local demand and export scope is rapidly increasing. But Bangladesh is not able to keeping pace with the demand and competition in the export market due to poor yield and seed scarcity of Eryngium. Although farmers of Hill tracts, Faridpur and Kishoreganj areas commercially cultivated this important high valued culinary herb obtained high return (Tk. 1.5-3.0 million/ha)
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(Mozumder et al., 2009). They face problems of higher seed cost, low germination rate and low yield with poor leaf quality that reduces their profit. Quality and yield of *Bilatidhonia* can be increased using improved cultivation techniques and making cucurbits trellis to provide optimum shades. In traditional cultivation system farmers obtained very low (6-10%) seed germination. For this they have to use a large amount of seeds (40 kg/ha) which required a high cost (Tk. 1,00,000/ha @ Tk 2,500/kg seed). On the other hand, seeds are always not available in the market. Therefore, seeds are appeared the major limiting factor for expanding cultivation of this valuable crop (Mozumder, 2003). Seeds are the major prerequisite for expansion of intensive cultivation of *Eryngium* to meet up the local demand and increase export. Improvisations *Eryngium* cultivation using line sowing treating growth regulator is essential to increase farmers profitability and livelihood through intensifying crop diversity, mitigating local demand and increased export to the foreign market. It required the standardization of improved *Eryngium* leaf production techniques at different agro-ecological zone of the country with a view to increase its production and profitability selecting proper sowing method and optimum shade.

2. MATERIALS AND METHODS

The experiment was conducted at two Regional Spices Research Stations at Gazipur (AEZ 28) and Magura (AEZ 11) during July 2012 to June 2014. The location 1 (Regional Spices Research Center, Gazipur) of the experimental site was about 40 km North to Dhaka city with 23° 59’ North latitude and 90.29o East longitude and an elevation of 12.10 m from the sea level. The experimental field belongs to the ‘Shallow red brown terrace’ soil of Salna series under Madhupur tract (AEZ 28) and the soil was Piedmont plain having medium loamy to moderately fine texture (sandy clay loam) with pH value 5.9. The location 2 (Regional Spices Research Center, Magura) was about 180 km West to Dhaka city with 23.29’18’ North latitude and 90°24’08’ East longitude and an elevation of 9.15 m from the sea level. The soil of the experimental field was medium loamy to moderately fine texture (loam) having pH value 6.8. The land was prepared thoroughly by ploughing and cross ploughing followed by ladderling and harrowing to have a good tilth. Experiments were conducted following split plot design with six treatments comprising two factors with three replications. The first factor “A” is comprised of three different shades such as 1) Black mosquito net (2 mm loop) shade, 2) Cucurbit trellis and 3) Control (no shade) was placed in the main plots. The second factor “B” is comprised of two sowing methods such as i) 10 cm line sowing and ii) Broadcasting were placed in the unit (sub) plot. The experimental land was fertilized with decomposed cowdung @ 15 t, 200 kg-N, 120 kg-P and 150 kg K /ha, respectively (Islam et al., 2003). The total amount of cowdung, TSP half of MOP and one fifth urea were applied as basal during final land preparation. The rest of urea and MOP were applied as top dressing in four equal installments at 7, 10, 13 and 16 week after sowing. All seeds were primed for 72 hours (8 hours soak and 4 hours drying for 6 times) and treated with growth regulator (GA: 500 ppm + Kinetin 50 ppm). The unit plot size was 3x3m (2 beds in each plot). Seeds of a released *Eryngium* variety (BARI Bilatidhonia-1) were sown on November 22 at Joydebpur and December 05 at Magura maintaining the treatment space and sowing system. Being seeds were very small, they were mixed with coarse sand for sowing uniformly. Broadcasting is the traditional sowing system of Bilatidhonia where line spacing was not maintained. The line spacing of 10 cm was maintained by making small furrows (2-3 cm width and 1.0-1.5 cm depth). Seeds of 1g/m² (10 kg/ha) were sown in the bed and mixed with upper surface (0.1 - 0.5 cm) of the soil. For line sowing, same rate of seeds was sown continuously in furrows and covered with thin layer (0.1 to 0.3 cm) of soil. After sowing, the beds were covered with dry straw and frequent irrigation was provided with watering cane with finely meshed nozzle to keep the soil and mulch moist. One pre-germination weeding was done at 7 days after sowing. The straws were removed and second weeding was done at the 15th day after seed sowing when few seedlings are visible on soil surface. Fifty-percent of viable seeds of all plots sprouted at 22 days after sowing. The number of seedlings/m² was counted and percentage of germination was calculated from that data compared with number of sown seeds/m². Weeding and mulching were done when necessary and top dressing of fertilizers were applied according to fertilizer application schedule (Islam et al., 2003). Black mosquito net was hanged with bamboo poles and GI wire for net shade and trellis was made with bamboo poles and nylon rope for the second treatment of factor A. Data were collected on days to germination and rate (%), number of seedlings/unit area, plant height, number of leaves, weight of single plants, and weight of cucurbits, fresh yield of *Eryngium* and cucurbits (t/ha), value of fresh *Eryngium* and cucurbits. Data from different research stations were collected calculated and analyzed using open source computer software R.
3. RESULTS AND DISCUSSION

Different shade methods and sowing methods showed significant variations on most of the quantitative and qualitative parameters in both locations.

Effect of shade method

Days to germination, number of seedlings/m² and germination rate were not significantly influenced by different shade method (Table 1.a). Early germination was recorded at Joydebpur (16.8 days) compared to Magura (20.5 days) in all treatments. The number of seedlings (1059/m²) and percentage of germination (46.46) was higher at Joydebpur than those of Magura (620/m², 27.17 resp.). The mean days to germination over location and treatment (18.7), seedlings/m² (826) and germination percentage (36.24) was very near to the previous report with similar variety using 2g/m² seeds resulted 16.3 days to germinate, 1268 seedlings/m² and 28.12% germination, respectively, (Mozumder, 2009).

Table 1a: Effect of shade method on germination performance of Eryngium

| Treatment  | Days to germination | Seedlings /m² | Germination % |
|------------|---------------------|----------------|---------------|
|            | Joydebpur | Magura | Mean | Joydebpur | Magura | Mean | Joydebpur | Magura | Mean |
| Nylon net  | 16.6      | 20.4   | 18.5 | 1035      | 633    | 834   | 45.41      | 27.78   | 36.60 |
| Veg.trellis| 16.8      | 20.0   | 18.4 | 1004      | 616    | 810   | 44.05      | 27.02a  | 35.54 |
| Control    | 17.1      | 21.1   | 19.1 | 1059      | 609    | 834   | 46.46      | 26.71   | 36.59 |
| Sig.level  | NS        | NS     | NS   | NS        | NS     | NS    | NS         | NS      | NS    |
| CV%        | 7.96      | 4.28   | 6.12 | 5.88      | 6.60   | 5.55  | 5.88       | 6.60    | 5.51  |

Number of harvested plants/m² and plant yield were significantly influenced by different shade method in both locations except single plant weight at Joydebpur (Table 1.b). More number of plants (605/m²) was harvested from the nylon net shade at Joydebpur while it was lower (305/m²) from open sunlight at Magura.

The maximum plant yield (33.00 t/ha) was obtained from nylon net shade at Joydebpur and it was lowest in control (16.94 t/ha) at Magura. This report resembled with the report of Moniruzzaman et al. (2000) that Eryngium yield reduced in open condition.

Table 1b: Effect of shade on field performance of Eryngium

| Treatment  | Harvested plants /m² | Single plant wt. (g) | Plant yield (t/ha) |
|------------|----------------------|----------------------|--------------------|
|            | Joydebpur | Magura | Mean | Joydebpur | Magura | Mean | Joydebpur | Magura | Mean |
| Nylon net  | 605a      | 390    | 497.5 | 5.44      | 7.25a  | 6.35a | 33.00a     | 28.96a  | 30.98 |
| Veg.trellis| 589ab     | 345    | 467.0 | 5.06      | 7.20a  | 6.13b | 29.99b     | 24.58ab | 27.28 |
| Control    | 568b      | 305    | 436.5 | 4.68      | 5.55b  | 5.12b | 23.86c     | 16.94b  | 20.40 |
| Sig.level  | *        | NS     | *    | NS        | **     | *    | **         | **      | **    |
| CV%        | 13.06     | 13.16  | 13.11 | 9.64      | 8.78   | 9.21  | 8.52       | 13.99   | 11.255 |

Means followed by same letter or without letter in a column are not differed significantly at 5% level. *, ** and NS indicate significant at 5%, 1% level and not significant respectively.

Mean of two locations in respect of leaf characteristics of Eryngium under different shade method are furnished in Table 1.c. Longer (15.0 cm) and more leaves/plant (6.95) was found under nylon net shade while wider leaves (2.29 cm) were found in control plot. Quality of leaves (appearance and softness) under black nylon net and cucurbit trellis were superior compared to control plot. The wholesale price of Eryngium produced under shades were BDT 100/kg for good quality soft and succulent leaves while price of leaves produced in open sunlight were only BDT 60/kg due to shorter spiny and low quality leaves. Consumers always prefer soft succulent and tender appearance of leaves that caused higher price of leaves grown under shades compared to that grown in open sunlight.
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Table 1c: Effect of shade on leaf characteristics of Eryngium (mean of two locations)

| Treatment   | Leaf length | Leaf width | No. of leaves/plant | Appearance of leaves | Leaf softness | Price of leaves (BDT/kg) | Leaf acceptability |
|-------------|-------------|------------|---------------------|----------------------|---------------|--------------------------|--------------------|
|             |             |            |                     |                      |               |                          |                    |
| Nylon net   | 16.1a       | 2.30b      | 7.57a               | Excellent            | Soft          | 100                      | Very good          |
| Veg.trellis | 14.9ab      | 2.25b      | 7.29a               | Excellent Good       | Soft          | 100                      | Very good          |
| Control     | 10.8b       | 2.90a      | 6.93b               | Excellent            | Less soft     | 60                       | Medium             |
| Sig. level  | **          | **         | **                  | **                   | **            | **                       | **                 |
| CV%         | 3.65        | 2.82       | 3.79                |                      |               |                          |                    |

Means followed by same letter or without letter in a column are not differed significantly at 5% level.

*, ** and NS indicate significant at 5%, 1% level, and not significant respectively.

Table 1f: Effect of shades on gross income from produces

| Treatment   | Plant value (Tk. 000/ha) | Vegetable value (Tk. 000/ha) | Total value (Tk. 000/ha) |
|-------------|--------------------------|-----------------------------|--------------------------|
|             | Joydebpur | Magura | Mean | Joydebpur | Magura | Mean | Joydebpur | Magura | Mean |
| Nylon net   | 1649.91a | 1443.23a | 1546.6a | 0.00b | 0.00b | 0.00b | 1443.23a | 1546.6a | 1577.2a |
| Veg.trellis | 1499.50b | 1228.91b | 1364.2b | 236.67a | 189.33a | 213.0a | 1418.24a | 507.98b | 611.8c |
| Control     | 715.68c  | 507.98c  | 611.8c  | 0.0b   | 0.0b   | 0.0b   | 1546.6a | 611.8c  | 1577.2a |
| Sig. level  | **        | **        | **      | **      | **      | **      | **      | **      | **     |
| CV%         | 8.85      | 12.98     | 10.92   | 13.30   | 3.88    | 8.59    | 12.63   | 8.48    | 10.56  |

Means followed by same letter or without letter in a column are not differed significantly at 5% level.

*, ** and NS indicate significant at 5%, 1% level, and not significant respectively.

Significant effect of shade methods observed in both the locations in respect of gross return, net return and benefit cost ratio (Table 1g). The maximum gross return and gross margin was obtained from nylon net shade (Tk. 3383.8 and 2933.8 thousands/ha, resp.) and it was lowest in control plot (Tk. 2450.1 and 2200.1). The highest BCR was also found in control (7.87) closely followed by nylon net shade (7.52) which was significantly lower in cucurbits trellis (7.16). The GR, NR and BCR of Joydebpur (3244.6, 2881.2 thousands/ha and 8.64) were better than Magura (3383.8 and 2933.8 thousands/ha, resp.) and it was lowest in control plot (Tk. 2450.1 and 2200.1). The highest BCR benefit cost ratio (Table 1g). The maximum gross return and gross margin was obtained from nylon net shade (Tk. 2504.5, 2141.2 thousand/ha and 7.52, respectively). Though the returns are lower in control plot but BCR was higher due to less variable cost involvement (Tk 2,50,000/ha) compared to nylon net (Tk. 4,50,000/ha) and cucurbits trellis (Tk. 3,90,000/ha). This result support the result of Moniruzzaman et al., (2000) that Eryngium cultivation under shade provided better returns and quality leaves compared to open sunlight.

Table 1g: Effect of shades on economic performance of Eryngium

| Treatment   | Gross return | Var. cost (Tk. 000/ha) | Gross margin (Tk. 000/ha) | BCR |
|-------------|---------------|------------------------|--------------------------|-----|
|             | Joydebpur | Magura | Mean | Joydebpur | Magura | Mean | Joydebpur | Magura | Mean |
| Nylon net   | 1649.91b | 1443.23a | 1546.6a | 450 | 3269.4a | 2598.2a | 2933.8a | 6.77a | 7.52a |
| Veg.trellis | 1736.17a | 1418.24a | 1577.2a | 390 | 2818.4b | 1981.2b | 2399.8b | 6.08c | 7.16b |
| Control     | 715.68c  | 507.98b  | 611.8c  | 250 | 2556.0c | 1844.2c | 2200.1b | 6.32b | 7.87a |
| Sig. level  | **        | **        | **      | **      | **      | **      | **      | **      | **     |
| CV%         | 9.50      | 6.91      | 8.21    | --      | 10.70    | 8.08    | 9.39    | 8.55    | 7.10   |

Means followed by same letter or without letter in a column are not differed significantly at 5% level.

*, ** and NS indicate significant at 5%, 1% level, and not significant respectively.

Nylon net shade provides uniform reduction of sunlight that ensures quality leaf, higher plant yield and moderate seed production of Eryngium. Nylon net shade required higher cost but it provided uniform sunlight that caused more yield and quality leaf resulted higher returns. Cucurbits trellis provided un-uniform dense shade that resulted better quality leaves but lower seed yield due to insufficient photosynthetic activities. On the other hand,
better seeds produced in open sunlight but leaves become spiny, quality deteriorated and fresh plant yield reduced in both the locations. Open field provided 100% sunlight resulted higher seed yield getting maximum sunlight for maximum photosynthetic facilities. Though the BCR was higher in open sunlight but gross return and margin were higher in nylon net and cucurbits shade having quality leaves with higher plant value. So, for light shades are suitable for both leaf and seed production but open sunlight might be used only for seed production.

Effect of sowing methods

All germination related parameters significantly influenced by different sowing method at Joydebpur except days to germination but all are insignificant at Magura (Table 2.a). The broadcast sowing method resulted higher germination percentage (46.73) and seedlings/m² (1065) compared to line sowing.

Table 2a: Effect of sowing method on germination performance of Eryngium

| Treatment       | Days to germination | Seedlings /m² | Germination % |
|-----------------|---------------------|---------------|--------------|
| Joydebpur       | Magura | Mean | Joydebpur | Magura | Mean | Joydebpur | Magura | Mean |
| Broadcasting    | 16.9    | 20.3 | 18.6 | 1049a | 625 | 837 | 46.00a | 27.43 |
| Line sowing     | 17.0    | 20.8 | 18.9 | 1011b | 607 | 809 | 44.34b | 26.60 |
| Sig. level CV%  | NS      | NS   | NS   | 5.88  | 6.60 | 6.24 | 5.88  | 6.60  |

Means followed by same letter or without letter in a column are not differed significantly at 5% level.
* , ** and NS indicate significant at 5%, 1% level and not significant respectively.

Fresh plant was only obtained from the plots where thinning was done at 120 DAS in both broadcast and line sowing. More number of plants was harvested from broadcasted plots compared to line sowing in both the locations that resulted higher fresh plant yield (Table 2.b). Single plant weight was not differed significantly due to different sowing method or thinning. Among two locations, more number of harvestable plants 283.9/m² and fresh plant yield (14.48 t/ha) were recorded at Joydebpur compared to Magura (173.5/m² and 11.10 t/ha, respectively). Single plant weight was slightly higher at Magura (3.33g) than Joydebpur (2.53g). Dense population caused lower single plant yield at Joydebpur. The maximum fresh yield (28.52 t/ha) was obtained from broadcast sowing while line sowing gave lower yield (23.90 t/ha).

Table 2b: Effect of sowing method on field performance of Eryngium

| Treatment       | Harvested plant /m² | Single plant wt. (g)* | Plant yield (t/ha) |
|-----------------|---------------------|-----------------------|-------------------|
| Joydebpur       | Magura | Mean | Joydebpur | Magura | Mean | Joydebpur | Magura | Mean |
| Broadcasting    | 618.8a | 374a | 496 | 5.10 | 6.63 | 5.87 | 31.85a |
| Line sowing     | 516.6b | 320b | 418 | 5.03 | 6.70 | 5.87 | 26.05b |
| Sig. level CV%  | *      | NS   | NS   | 9.64 | 8.78 | 9.2  | 8.52  |

Means followed by same letter or without letter in a column are not differed significantly at 5% level.
* , ** and NS indicate significant at 5%, 1% level and not significant respectively.

Leaf characteristics were not varied with different sowing methods of Eryngium (Table 2.c) in both the locations. Leaf size and number of leaves/plant as well as qualitative parameters was similar in broadcast or line sowing with or without thinning. Appearance of leaves, softness and consumers acceptability seems unchanged with various sowing methods in both locations.

Table 2c: Effect of sowing method on leaf characteristics of Eryngium (mean of 2 locations)

| Treatment       | Leaf length | Leaf width | No of leaves /plant | Leaf appearance | Softness | Leaf acceptability |
|-----------------|-------------|------------|---------------------|-----------------|----------|-------------------|
| Joydebpur       | Magura      | Mean       | Joydebpur | Magura | Mean | Joydebpur | Magura | Mean |
| Broadcast       | 14.10       | 2.49       | 6.94       | Good          | Soft     | Good          |
| Line sowing     | 13.90       | 2.49       | 6.86       | Good          | Soft     | Good          |
| Sig. level CV%  | NS          | NS         | NS         | --            | --       | --             |

Means followed by same letter or without letter in a column are not differed significantly at 5% level.
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Economic performance of *Eryngium* was greatly influenced by sowing methods and thinning (Table 2.f). The highest mean plant value (Tk. 2571.7 thousands/ha) was obtained from broadcast followed by line sowing and thinning (Tk. 2125.1 thousand/ha) and no returns were found from without thinning. Thinning provides more profit due to dual return from both fresh plants and seeds. Returns from vegetables were equally distributed because all sowing methods provided with similar shade facilities. The highest seed value (Tk. 1874.3 thousand/ha) was obtained from line sowing without thinning and it was lowest in broadcasting with thinning (Tk. 1340.6 thousands/ha). All the returns were higher at Joydebpur compared to Magura but the treatment values showed similar trend.

| Treatment        | Plant value (Tk.000/ha) | Veg. value (Tk.000/ha) | Seed value (Tk.000/ha) |
|------------------|-------------------------|------------------------|------------------------|
|                  | Joydebpur | Magura | Mean | Joydebpur | Magura | Mean | Joydebpur | Magura | Mean |
| Broadcast (BC)   | 2860.7a   | 2229.7b | 2572.7 | 78.9 | 63.1 | 71.0 | 2739.6 | 2203.6 | 2472.6 |
| Line sowing (LS) | 2292.72a | 1957.53b | 2125.1 | 78.9 | 63.1 | 71.0 | 2371.62 | 2020.63 | 2196.1 |
| Sig.level        | **        | **     | NS   | 12.3 | 3.88 | 8.59 | **       | **     | **   |
| CV%              | 8.85      | 12.98  | 10.92 | 8.85 | 10.92 | 8.59 | 12.3 | 8.48   | 10.56 |

Means followed by same letter or without letter in a column are not differed significantly at 5% level.

* *, ** and NS indicate significant at 5%, 1% level and not significant respectively.

Different sowing methods and thinning resulted significant variation in gross return (GR), gross margin (GM) and benefit cost ratio (BCR) in *Eryngium* cultivation under both the locations of Joydebpur and Magura (Table 2.g). The maximum gross return and gross margin was obtained from broadcast sowing with thinning (Tk. 3983.2 and 3619.9 thousands/ha) and it was lowest in broadcast sowing without thinning (Tk. 1828.4 and 1465.1 thousands/ha, respectively).

| Treatment        | GR (Tk.000/ha) | GM (Tk.000/ha) | BCR          |
|------------------|----------------|----------------|--------------|
|                  | Joydebpur | Magura | Mean | Joydebpur | Magura | Mean | Joydebpur | Magura | Mean |
| Broadcast (BC)   | 1977.0b   | 1679.8c | 1828.4b | 1613.7b | 1316.4c | 1465.1b | 5.27b | 4.98c | 5.13b |
| Line sowing (LS) | 2264.1b   | 1646.4c | 1955.3b | 1900.7b | 1283.1c | 1591.9b | 6.22b | 4.88c | 5.55b |
| Location mean    | 3244.57   | 2504.54 | 2874.56 | 2381.24 | 2141.21 | 2511.22 | 7.08 | 7.86 |
| Sig.level        | **        | **     | **    | **       | **     | **   | **       | **     | **   |
| CV%              | 9.50      | 6.91   | 8.20  | 10.70    | 8.08   | 9.39 | 8.55    | 7.10   | 7.83 |

Means followed by same letter or without letter in a column are not differed significantly at 5% level.

* *, ** and NS indicate significant at 5%, 1% level and not significant respectively.

The highest BCR (10.66) was found in broadcast sowing with thinning closely followed by line sowing with thinning (10.1) which was significantly different from broadcast and line sowing without thinning (5.13 and 5.55, respectively). Both line sowing and broadcasting, thinning facilitate higher returns obtaining a handsome amount of money by selling of fresh plants that harvested during thinning.

**Combined effect of shade and sowing method**

Days to germination, number of seedlings/m² and germination percentage did not show significant variation due to different shades and sowing method in combination of two locations but variations observed in number of seedlings and germination percentage at Joydebpur (Table 3.a). *Eryngium* seeds took 16-18 days for germination at Joydebpur while it required 19-21 days at Magura with mean germination period (18.7 days). Delayed sowing (05
December sowing) and low temperature resulted longer germination period at Magura compared to Joydebpur (22 November sowing).

The maximum number of seedlings (1056/m²) and percentage of germination (46.46) were recorded in broadcast sowing without shade (control) at Joydebpur while it was lowest (589/m² and 25.85%) from line sowing under vegetables trellis at Magura. Moniruzzaman et al. (2000) found insignificant variation in germination of *Eryngium* under different shade methods. Mozumder et al.,(2011) also found higher germination in broadcasting and line sowing 10 cm apart compared to 15 and 20 cm line sowing apart of *Eryngium*.

Number of harvested plants/m², single plant weight and fresh plant yield significantly varied due to the combined effects of sowing method and shades in both locations (Table 3.b). At Joydebpur, more number of harvestable plants 283.9/m² and fresh plant yield (14.48 t/ha) were recorded compared to Magura (178.4/m² and 11.74 t/ha, respectively). Single plant weight was slightly higher at Magura (3.33g) than Joydebpur (2.53g). The maximum number of harvested plants (655/m²) and fresh yield (28.52 t/ha) were obtained from broadcast sowing with thinning under nylon net shade at Joydebpur while line sowing without shade gave the minimum number of harvested plants (293/m²) and fresh plant yield (16.20 t/ha) at Magura. The single plant weight was found highest (7.4 g) in line sowing with thinning under nylon net shade at Magura and it was lowest in control (4.6 g) with broadcast sowing at Joydebpur. This report resembled with the report of Moniruzzaman et al. (2000) that single plant weight and fresh plant yield of *Eryngium* reduced in open condition. Higher yield and better quality leaves were obtained by Moniruzzaman et al. (2007) with black color nylon net shade that cut off about 50% sunlight.

| Treatment | Days to germination | Seedlings /m² | Germination % |
|-----------|---------------------|---------------|--------------|
|           | Joy. | Magura | Mean | Joydebpur | Magura | Mean | Joydebpur | Magura | Mean |
| **Cont.** |       |         |      |          |        |       |          |        |       |
| Nylon     |       |         |      |          |        |       |          |        |       |
| Veg. trel |       |         |      |          |        |       |          |        |       |
| Roll      |       |         |      |          |        |       |          |        |       |
| Broadcast (BC) | 16.3 | 20.3 | 18.3 | 1047bc | 677 | 862 | 45.92bc | 29.71 | 37.8 |
| Line sowing (LS) | 16.7 | 21.0 | 18.8 | 1030c | 616 | 823 | 45.19c | 27.00 | 36.1 |
| Broadcast (BC) | 16.7 | 19.3 | 18.0 | 1063abc | 622 | 843 | 46.64abc | 27.28 | 36.96 |
| Line sowing (LS) | 16.6 | 20.0 | 18.4 | 957d | 612 | 785 | 41.99d | 26.83 | 34.41 |
| Broadcast (BC) | 17.0 | 21.0 | 19.0 | 1086a | 606 | 846 | 47.63a | 26.56 | 37.1 |
| Line sowing (LS) | 17.0 | 21.3 | 19.2 | 1033c | 606 | 820 | 45.29c | 26.58 | 35.94 |

Means followed by same letter or without letter in a column are not differed significantly at 5% level. *, ** and NS indicate significant at 5%, 1% level and not significant respectively.

### Table 3b: Combined effect of shade and sowing method on field performance of *Eryngium*

| Treatment | Harvested plant /m² | Single plant wt. (g) | Plant yield (t/ha) |
|-----------|---------------------|----------------------|--------------------|
|           | Joydebpur | Magura | Mean | Joydebpur | Magura | Mean | Joydebpur | Magura | Mean |
| **Cont.** |       |         |      |          |        |       |          |        |       |
| Nylon     |       |         |      |          |        |       |          |        |       |
| Veg. trel |       |         |      |          |        |       |          |        |       |
| Roll      |       |         |      |          |        |       |          |        |       |
| Broadcast (BC) | 655.0a | 444a | 550a | 5.57a | 7.1a | 6.34a | 36.45a | 29.55b | 32.15a | 34.30 |
| Line sowing (LS) | 554.0b | 337bc | 446b | 5.33ab | 7.4a | 6.37a | 29.55b | 25.58b | 32.15a | 27.57 |
| Broadcast (BC) | 674.3a | 361b | 518a | 5.13ab | 7.2a | 6.17aa | 34.79a | 25.19bc | 25.74b | 30.27 | 24.31 |
| Line sowing (LS) | 503.0b | 329bc | 416b | 5.00bc | 7.2a | 6.10 | 25.19bc | 23.42b | 25.74b | 30.27 | 24.31 |
| Broadcast (BC) | 527.0b | 317bc | 422b | 4.60cd | 5.6b | 5.10b | 24.31c | 23.41d | 17.796c | 21.05 |
| Line sowing (LS) | 492.7c | 293c | 393c | 4.77d | 5.5b | 5.14b | 17.796c | 16.20c | 17.796c | 19.81 |

Means followed by same letter or without letter in a column are not differed significantly at 5% level.
Effect of Shade and Sowing Method on Eryngium Foetidum Production

*, ** and NS indicate significant at 5%, 1% level and not significant respectively.

Leaf width and number of leaves per plant were not differed but length and quality of leaves varied with combination of different shades and sowing method of *Eryngium* in both the locations (Table 3.c). The maximum leaf length (16.2 cm) were obtained from broadcasting and line sowing with thinning under nylon net shade while it was minimum (10.8 cm) in line sowing without shade. Appearance of leaf, softness and consumers acceptability seems better in nylon shades and cucurbits trellis. Plants grown in open sunlight showed spiny, hard, small and poor quality leaves that are not preferred by the consumers.

| Table 3c: Combined effect of shade and sowing method on leaf characteristics of *Eryngium* |
|-----------------------------------------------|
| Treatment | Leaf length (cm) | Leaf width (cm) | No of leaves/plant | Appearance of leaves | Leaf softness | Leaf acceptability |
| Nylon | | | | | | |
| Broadcast Line sowing | 16.2a | 2.32 | 7.55 | Excellent | Soft | Very good |
| Line sowing | 16.2a | 2.32 | 7.59 | Excellent | Soft | Very good |
| Broadcast Line sowing | 15.0ab | 2.23 | 7.35 | Excellent | Soft | Very good |
| Line sowing | 14.7b | 2.27 | 7.12 | Excellent | Soft | Very good |
| Veg.trel | | | | | | |
| Broadcast Line sowing | 11.0c | 2.92 | 5.91 | Good | Less soft | Medium |
| Line sowing | 10.8c | 2.87 | 5.78 | Good | Less soft | Medium |
| Control | | | | | | |
| Broadcast Line sowing | 11.0 | 2.92 | 5.91 | Good | Less soft | Medium |
| Line sowing | 10.8 | 2.87 | 5.78 | Good | Less soft | Medium |

Sig.level CV% | * | NS | NS | -- | -- | --
| 3.65 | 2.815 | 3.79 | -- | -- | --

Means followed by same letter or without letter in a column are not differed significantly at 5% level. *, ** and NS indicate significant at 5%, 1% level and not significant respectively.

Returns from different components in Bilatidhonia leaf and seed production was greatly influenced by the combined effects of different shades and sowing methods (Table 3.f).

| Table 3f: Combined effect of shade and sowing method on returns in *Eryngium* cultivation |
|-----------------------------------------------|
| Treatment | Plant value (Tk. 000/ha) | Veg. value (Tk. 000/ha) | Seed value (Tk. 000/ha) |
| Joydebpur | Magura | Mean | Joydebpur | Magura | Mean | Joydebpur | Magura | Mean |
| Nylon | | | | | | | | | |
| Broadcast Line sowing (LS) | 3644.7a | 2954.9bc | 3214.7a | 2558.2b | 3429.7a | 2756.6b | 0.00b | 0.00b | 0.0b |
| Line sowing (LS) | 3715.9ab | 2755.5c | 3239.4b | 2643.5b | 3429.7a | 2756.6b |
|广播 (BC) | 3214.7a | 2558.2b | 3429.7a | 2756.6b |
| Veg.trel | | | | | | | | | |
| Broadcast Line sowing (LS) | 3479.2a | 2518.8c | 3026.4b | 2430.5b | 236.7a | 236.7a | 189.3a | 213.0a | 213.0a |
| Line sowing (LS) | 3715.9ab | 2755.5c | 3239.4b | 2643.5b | 3429.7a | 2756.6b |
|播种 (BC) | 3214.7a | 2558.2b | 3429.7a | 2756.6b |
| Control | | | | | | | | | |
| Broadcast Line sowing (LS) | 1458.3d | 1404.4d | 1259.0c | 1188.3c | 0.00b | 0.00b | 0.00b | 0.00b | 0.00b |
| Line sowing (LS) | 1458.3d | 1404.4d | 1259.0c | 1188.3c |

Significant level CV% | ** | ** | ** | ** | ** | ** | ** | ** |
| 8.85 | 12.98 | 8.21 | 13.30 | 3.88 | 9.39 | 12.63 | 8.48 | 10.56 |

Means followed by same letter or without letter in a column are not differed significantly at 5% level.
The highest mean plant value (Tk. 3429.7 thousands/ha) was obtained from nylon net shade in broadcast sowing and thinning followed by cucurbits trellis shade with same sowing method (Tk. 3026.4 thousand/ha) and lower returns (Tk. 1188.3 thousand/ha) came from line sowing and thinning without shade. No returns were found from plot where thinning was not done. Thinning facilitate more profit due to dual return from both fresh plants and seeds. Only cucurbit trellis provided some income (Tk. 213.0 thousands/ha) from vegetables. The highest seed value was gained from open sunlight and line sowing without thinning (Tk. 2228.3 thousands/ha) which was closely followed by the nylon net shade with broadcast sowing methods (Tk. 2130.0 thousand/ha) and it was lowest in cucurbits trellis with broadcast sowing and thinning (Tk. 961.1 thousands/ha). All values were higher at Joydebpur compared to Magura might be due to higher plant and seed yield as well as vegetable yield from trellis probably the result of better germination and higher plant population.

Different combinations of shades and sowing method and thinning resulted significant variations in gross return (GR), gross margin (GM) and benefit cost ratio (BCR) in Eryngium cultivation under both the locations Joydebpur and Magura (Table 3.g). The maximum gross return and gross margin was obtained from nylon net shade and broadcast sowing with thinning (Tk. 4944.2 and 4438.2 thousands/ha) followed by same shade and line sowing with thinning (Tk. 4409.9 and 3859.9 thousands/ha) and it was lowest in cucurbits shade and broadcast sowing without thinning (Tk. 1523.6 and 1133.6 thousands/ha, respectively).

**Table 3g:** Combined effect of shade and sowing method on economic performance of Eryngium

| Treatment | Location | Gross return (Tk. 000/ha) | Gross margin (Tk. 000/ha) | BCR |
|-----------|----------|--------------------------|---------------------------|-----|
|           |          | Joydebpur    | Magura     | Joydebpur    | Magura     | Joydebpur    | Magura     | Joydebpur    | Magura     |           |
| Nonyl net | Broadcat (BC) | 2500.0cd e | 5200.3a 2388.9de | 1760.0e 4688.1a 1713.3e 4031.5b | 2130.0d 4944.2a 2051.1d 4409.9a b | 2050.0de f 4750.2a 1938.8de f 4338.27a | 1310.0e f 4238.0a 1263.3e f 3581.5b | 1680.0d e 4438.2a 1601.1e 3859.9a b | 5.56de 10.99e 5.309e 10.64bc | 3.91e 8.96bc 3.81e 8.96bc |
| Nonyl net | Line sowing (LS) & thinning | 1597.8f 4938.1a 1736.7ef 4561.0a | 1449.3e 3462.8c 1436.0e 3136.5c | 1523.6e 4200.5a b 1586.4e 3848.8b | 1207.7f 4548.1a 1346.7ef 4171.0a | 1059.3f 3072.8c 1046.0f 2746.5c | 1133.6f 3810.5a b 1196.3f 3458.7b | 4.10e 12.66a 4.45e 11.69abc | 3.72e 8.88bc 3.68e 8.04cd |
| Veg.trellis | Broadcat (BC) | 1833.3ef 3180.5bc 2666.7cd 3543.3b | 1580.0e 2179.6d 1540.0e 2077.2d | 1706.7d e 2680.1c 2103.7d 2810.3c | 1583.3ef 2930.5bc 2416.7cd 3293.3b | 1330.0f 1929.6d 1290.0f 1827.2d | 1556.7e 2430.1c 1853.4d 2560.3c | 6.15d 10.69bc 8.89c 11.97ab | 7.32d 9.72ab 9.31ab 8.03c |
| Veg.trellis | Line sowing (LS) & thinning | 2906.8 | 2421.2 | 2664.8 | 2656.24 | 2171.2 | 2404.0 | 8.64 | 7.08 | 7.86 |
Effect of Shade and Sowing Method on Eryngium Foetidum Production

| Significant level CV% | **9.50** | **6.91** | **8.20** | **10.70** | **8.08** | **9.40** | **8.55** | **7.10** | **7.83** |
|-----------------------|----------|----------|----------|-----------|----------|----------|----------|----------|----------|

Means followed by the same letter or without letter in a column are not differed significantly at 5% level.

* and ** indicate significant at 5% and 1% level respectively.

The highest BCR (10.99) was found in broadcast sowing with thinning under nylon net shade closely followed by line sowing with thinning under cucurbit trellis (10.77) though the lowest BCR (4.07) was found in broadcast sowing without thinning under same shade. Both line sowing and broadcasting under different shades, thinning facilitate higher returns obtaining extra returns by selling of fresh plants that harvested during thinning. Without thinning of all sowing method and shades gave lower returns because only seed values and vegetables values (Cucurbits shade) are considered for return calculation.

4. CONCLUSION

All kinds of sowing and shade methods with thinning gave higher returns as well as benefit cost ratio compared to control (no thinning). For better leaf production, broadcasting sowing with thinning under nylon net shade found better and more profitable. Cultivation of Eryngium under cucurbit trellis gave early returns that can be recommended for fresh leaf production. Open sunlight is less costly but it is not suitable for leaf production.

5. RECOMMENDATION

Broadcasting sowing with thinning plus shade (either nylon or cucurbit trellis) are suggested for better leaf production of Eryngium.

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CONFLICT OF INTEREST

The author have declared that no competing interests exist.

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