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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/m^2) 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/m^2) 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, Bangladhonia, culantro, cilantro, spiny coriander or long coriander is a high valued perennial aromatic herb belongs to the family Apiaceae (Umbellifarae). 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)

(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 23^0 59' North latitude and 90.29^o East longitude and an elevation of 12.10 m from the sea level. The experimental field belongs 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 89^o24'08'' 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 laddering 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_3 500 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 $1g/m^2$ (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 15^{th} 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/m^2 was counted and percentage of germination was calculated from that data compared with number of sown seeds/m^2. 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/m^2 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/m^2) and percentage of germination (46.46) was higher at Joydebpur than those of Magura (620/m^2, 27.17 resp.). The mean days to germination over location and treatment (18.7), seedlings/m^2 (826) and germination percentage (36.24) was very near to the previous report with similar variety using 2g/m^2 seeds resulted 16.3 days to germinate, 1268 seedlings/m^2 and 28.12% germination, respectively, (Mozumder, 2009).

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

Treatment	Days to germination			Seedlings /m^2			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/m^2 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/m^2) was harvested from the nylon net shade at Joydebpur while it was lower (305/m^2) 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 /m^2			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.

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	Soft	100	Very good
Control	10.8b	2.90a	6.93b	Good	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	0.0b	1649.91 b	1443.23a	1546.6a
Veg.trellis	1499.50b	1228.91b	1364.2b	236.67a	189.33a	213.0a	1736.17a	1418.24a	1577.2a
Control	715.68c	507.98c	611.8c	0.00b	0.00b	0.0b	715.68c	507.98b	611.8c
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 1.g). 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 (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	1649.91 b	1443.23a	1546.6a	450	3269.4a	2598.2a	2933.8a	8.27b	6.77a	7.52a
Veg.trellis	1736.17a	1418.24a	1577.2a	390	2818.4b	1981.2b	2399.8b	8.23b	6.08c	7.16b
Control	715.68c	507.98b	611.8c	250	2556.0c	1844.2c	2200.1b	9.42a	6.32b	7.87a
Sig.level	**	**	**	--	**	**	**	**	**	**
CV%	9.50	6.91	8.21		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.

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/m^2 (1065) compared to line sowing.

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

Treatment	Days to germination			Seedlings /m^2			Germination %		
	Joydebpur	Magura	Mean	Joydebpur	Magura	Mean	Joydebpur	Magura	Mean
Broadcasting	16.9	20.3	18.6	1049a	625	837	46.00a	27.43	36.72
Line sowing	17.0	20.8	18.9	1011b	607	809	44.34b	26.60	35.47
Sig. level	NS	NS	NS	*	NS	NS	*	NS	NS
CV%	7.96	4.28	6.12	5..88	6.60	6.24	5..88	6.60	6.24

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/m^2 and fresh plant yield (14.48 t/ha) were recorded at Joydebpur compared to Magura (173.5/m^2 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 /m^2			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	25.18a	28.52a
Line sowing	516.6b	320b	418	5.03	6.70	5.87	26.05b	21.74b	.23.90b
Sig.level	*	*	*	NS	NS	NS	**	**	
CV%	13.06	13.16	13.11	9.64	8.78	9.2	8.52	13.99	11.26

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
Broadcast	14.10	2.49	6.94	Good	Soft	Good
Line sowing	13.90	2.49	6.86	Good	soft	Good
Sig.level	NS	NS	NS	--	--	--
CV%	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.

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.

Table 2f: Effect of sowing methods on produced return in *Eryngium* cultivation

Treatment	Plant value (Tk. 000/ha)			Veg. value (Tk. 000/ha)			Seed value (Tk. 000/ha)		
	Joydebpur	Magura	Mean	Joy.	Magura	Mean	Joydebpur	Magura	Mean
Broadcast (BC)	2860.7a	2282.6a	2571.7	78.9	63.1	71.0	2939.6	2345.7	2642.7
Line sowing (LS)	2292.72b	1957.53b	2125.1	78.9	63.1	71.0	2371.62	2020.63	2196.1
Sig.level	**	**	**	NS	NS	NS	**	**	**
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.

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).

Table 2g: Effect of sowing methods on economic performance of *Eryngium*

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	8.64	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/m^2 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).

Table 3a: Combined effect of shade and sowing method on germination of *Eryngium*

Treatment		Days to germination			Seedlings /m²			Germination %		
		Joy.	Magura	Mean	Joydebpur	Magura	Mean	Joydebpur	Magura	Mean
Nylon net	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
Veg.trellis	Broadcast (BC)	16.7	19.3	18.0	1063abc	622	843	46.64abc	27.28	36.96
	Line sowing (LS)	16.7	20.0	18.4	957d	612	785	41.99d	26.83	34.41
Control	Broadcast (BC)	17.0	21.0	19.0	1086a	606	846	47.63a	26.56	37.10
	Line sowing (LS)	17.0	21.3	19.2	1033c	606	820	45.29c	26.58	35.94
Sig.level		NS	NS	NS	*	NS	NS	*	NS	NS
CV%		7.96	4.28	6.12	5..88	6.60	2.94	5..88	6.60	6.24

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 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.

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
Nylon net	Broadcast (BC)	655.0a	444a	550a	5.57a	7.1a	6.34a	36.45a	32.15a	34.30
	Line sowing (LS)	554.0b	337bc	446b	5.33ab	7.4a	6.37a	29.55b	25.58b	27.57
Veg.trellis	Broadcast (BC)	674.3a	361b	518a	5.13ab	7.2a	6.17aa	34.79a	25.74b	30.27
	Line sowing (LS)	503.0b	329bc	416b	.5.00bc	7.2a	6.10	25.19bc	23.42b	24.31
Control	Broadcast (BC)	527.0b	317bc	422b	4.60cd	5.6b	5.10b	24.31c	17.796c	21.05
	Line sowing (LS)	492.7c	293c	393c	4.77d	5.5b	5.14b	23.41d	16.20c	19.81
Sig.level		*	**	*	*	**	*	**	**	**
CV%		13.06	13.16	13.11	9.64	8.78	9.21	8.52	13.99	11.26

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 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	16.2a	2.32	7.55	Excellent	Soft	Very good
	Line sowing	16.2a	2.32	7.59	Excellent	Soft	Very good
Veg.trel.	Broadcast	15.0ab	2.23	7.35	Excellent	Soft	Very good
	Line sowing	14.7b	2.27	7.12	Excellent	Soft	Very good
Control	Broadcast	11.0c	2.92	5.91	Good	Less soft	Medium
	Line sowing	10.8c	2.87	5.78	Good	Less soft	Medium
Sig.level		*	NS	NS	--	--	--
CV%		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 (BC)	3644.7a	3214.7a	3429.7a	0.00b	0.00b	0.0b	/3644.7a	3214.7a	3429.7a
	Line sowing (LS)	2954.9bc	2558.2 b	2756.6 b	0.00.b	0.00b	0.0b	2954.9bc	2558.2 b	2756.6 b
Veg.trel	Broadcast (BC)	3479.2a b	2573.5 b	3026.4 b	236.7a	189.3a	213.0 a	3715.9ab	2762.8 b	3239.4 b
	Line sowing (LS)	2518.8c	2342.1 b	2430.5 b	236.7a	189.3a	213.0 a	2755.5c	2531.4 b	2643.5 b
Control	Broadcast (BC)	1458.3d	1059.6c	1259.0c	0.00b	0.00b	0.00b	1458.3d	1059.6c	1259.0c
	Line sowing (LS)	1404.4d	972.2c	1188.3c	0.00b	0.00b	0.00b	1404.4d	972.2c	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.

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

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		Gross return (Tk. 000/ha)			Gross margin (Tk. 000/ha)			BCR		
	Location	Joydebpur	Magura	Mean	Joydebpur	Magura	Mean	Joydebpur	Magura	Mean
Nylon net	Broadcast (BC)	2500.0cde	1760.0e	2130.0d	2050.0de	1310.0ef	1680.0de	5.56de	3.91e	4.74de
	BC & thinning	5200.3a	4688.1a	4944.2a	4750.2a	4238.0a	4438.2a	11.56abc	10.42a	10.99a
	Line sowing (LS)	2388.9de	1713.3e	2051.1d	1938.8def	1263.3ef	1601.1e	5.309e	3.81e	4.56e
	LS & thinning	4788.3a	4031.5b	4409.9ab	4338.27a	3581.5b	3859.9ab	10.64bc	8.96bc	9.80b
Veg.trellis	Broadcast (BC)	1597.8f	1449.3e	1523.6e	1207.7f	1059.3f	1133.6f	4.10e	3.72e	3.91d
	BC & thinning	4938.1a	3462.8c	4200.5ab	4548.1a	3072.8c	3810.5ab	12.66a	8.88bc	10.77a
	Line sowing (LS)	1736.7ef	1436.0e	1586.4e	1346.7ef	1046.0f	1196.3f	4.45e	3.68e	4.07e
	LS & thinning	4561.0a	3136.5c	3848.8b	4171.0a	2746.5c	3458.7b	11.69abc	8.04cd	9.87b
Control	Broadcast (BC)	1833.3ef	1580.0e	1706.7de	1583.3ef	1330.0f	1556.7e	6.15d	7.32d	6.74d
	BC & thinning	3180.5bc	2179.6d	2680.1c	2930.5bc	1929.6d	2430.1c	10.69bc	9.72ab	10.21a
	Line sowing (LS)	2666. 7cd	1540.0e	2103.7d	2416.7cd	1290.0f	1853.4d	8.89c	7.16d	8.03c
	LS & thinning	3543.3b	2077.2d	2810.3c	3293.3b	1827.2d	2560.3c	11.97ab	9.31abc	10.64a
Location mean		2906.8	2421.2	2664.8	2656.24	2171.2	2404.0	8.64	7.08	7.86

Significant level	**	**	**	**	**	**	**	**	**
CV%	9.50	6.91	8.2	10.70	8.08	9.4	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 ** 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 cucurbits 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 cucurbits 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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