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Effect of plant growth regulators and seed rate on *Eryngium* production

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ABSTRACT

An experiment was conducted at the Horticulture Field Laboratory of Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur during November 2005 to July 2006 to evaluate the effect of gibberellic acid (GA_3), kinetin and seed rate on yield and profitability of *Erygium foertidum*. Eight combinations of hormones comprising GA_3 at 100, 500, 1000 ppm; kinetin at 10, 50, 100 ppm; GA_3 500 ppm plus kinetin 50 ppm and control (distilled water) with three seed rates, *viz.*, 20, 30 and 40 kg/ha were used. Application of GA_3 and kinetin individually and in combination significantly increased seed germination as well as yield of *Eryngium*. Maximum number of plants (1592/m^2) was obtained from the mixed application of GA_3 (500 ppm) and kinetin (50 ppm) with 40 kg seed/ha, while maximum fresh weight (6.87 kg/m^2), fresh yield (54.94 t/ha), gross return (Tk. 13,73,300/ ha) and net return (Tk. 10,86,500/ha) was obtained from the same hormonal treatment with 30 kg seed/ha. The maximum benefit-cost ratio (5.08), benefit over control (Tk. 6,36,200/ ha), percentage benefit over control (56.7) were obtained from mixed hormone (GA_3 500 ppm + kinetin 50 ppm) application along with 20 kg seed /ha.

Key words: *Erygium* sp., GA_3, kinetin, yield, economics of cultivation.

INTRODUCTION

Eryngium foetidium L. is a major cash crop in the hilly region of Bangladesh (Moniruzzaman, 5) and cultivated from the early time by the tribals. It has been proved that this crop can also be grown well in the different parts of the country (Moniruzzaman, 5). Now a days, it is popular to the native consumers and a remarkable extent is being exported to the UK and Middle East markets for its popularity as culinary herb. Medicinal values of this plant have also been reported (Leclercq *et al.*, 4; Wong *et al.*, 11). Yield of any crop is directly related to seed quality, *i.e.*, germination rate, vigour etc. However, in *Eryngium*, poor and non-uniform seed germination is a major problem, which hinders the expansion of its cultivation through out the country. On the other hand very low germination influences the higher seed rate associated with high expenditure for its cultivation. Due to unavailability of adequate amounts of seeds, limits its cultivation and expansion. To overcome this problem the germination rate should be increased. A number of reports showed that germination of coriander can be increased and enhanced using GA_3 and kinetin (Naidu and Rajendra, 9; Mozumder *et al.*, 8). Using such chemicals increased germination may reduce seed cost and also more area can be cultivated with a limited amount of seed. The present experiment was designed with an emphasis to get profit with the application of growth regulators and lowering the seed rate to maintain an acceptable yield potentiality.

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MATERIALS AND METHODS

The experiment was conducted during November 2005 to July 2006 at the Horticulture Field Laboratory of Bangabandhu Sheikh Mujibur Rahman Agricultural University, Salna, Gazipur situated in the middle part of Bangladesh (24^{0}00'N Lat. and 90^{0}26'E Long.). The experimental field belonged to AEZ-28 and the soil was Brown Terrace but modified (through land development) to medium loamy to moderately fine texture (sandy clay loam). The experiment was laid out in a split plot design giving hormone treatment in the main plot and seed rate in the sub plot with three replications of 3 m x 1 m bed size. Eight treatment combination of hormones comprising GA_3 100 ppm, GA_3 500 ppm, GA_3 1000 ppm, kinetin 10 ppm, kinetin 50 ppm, kinetin 100 ppm, GA_3 500 ppm + kinetin 50 ppm and control (distilled water) with three seed rates, *viz.*, 20, 30 and 40 kg/ha were used in the experiments. Seed were soaked with different hormone solutions and distilled water for 15 min. then air-dried in shade. The experimental land was fertilized with decomposed cowdung @ 15 t/ha, 200 kg-N, 120 kg-P and 150 kg-K (Islam *et al.*, 2). The total amounts of cowdung, P and one fourth of N and K were applied during final land preparation. The rest of the N and K were applied in three equal installments at 45, 75 and 105 days after sowing. Seeds of *Eryngium* were sown by broadcasting and mixed with soil at 0.1-1.0 cm depth. Bamboo with black mosquito net (2 mm loop) covered light shade was made to discard about 50% sunlight to ensure lengthy and succulent leaves (Moniruzzaman, 5). Thinning was done at the time of harvest when longer (leaf) plants were picked up for marketing. Weeding was done before emergence, before fertilizer top dressing, after every harvest and whenever necessary. Irrigation and other cultural practices have been done as and when necessary. A number of flower stalks were produced and it was broken so that more leaves can be produced. Harvesting was done from the last week of May to the second week of July with an interval of 20 days when the leaves became most succulent.

Data on number of plants, plant height and number of leaves per plant, leaf size and individual plant weight were taken from 10 plants from each harvest in every plot. The total number of plants/m^2, fresh yield was calculated from the summation of all yields of each plot. Individual plant performance, leaf size etc. were calculated from the average of all harvests, and the total yield and biomass were calculated from the cumulative data. Total variable cost was calculated considering the market value of fertilizers, hormone, seeds (Tk. 1800/kg; 1 Bangladeshi Taka = 0.04 US$); laborer (Tk. 120/day). Gross return was calculated considering whole sale price of *Eryngium* (Tk. 25/kg). The data were compiled properly and analyzed statistically by MSTAT Programme and mean comparison was done following the Duncan's Multiple Range Test (Zaman *et al.*, 12).

RESULTS AND DISCUSSION

Number of plants/m^2 was higher in GA_3 and kinetin treated plots over control. This was due to seed germination was higher with growth regulator application (Mozumder *et al.*, 8). The highest number of plants (1461/m^2) was obtained from the combined application of kinetin (50 ppm) plus GA_3 500 ppm, while it was lower in control (987/m^2). Earlier, Samaan *et al.* (10**)** reported that kinetin could increase seed germination replacing the effect of moist chilling. The cause of enhanced germination with GA_3 and kinetin is enhanced due to higher amylase activity induced by applied GA_3. Ekpong (1) reported that seed soaking in growth regulator solution increased seed germination. Moraes *et al.* (7) found increased seed germination in coriander with growth regulator application. This result ensured the report of Khider (3) that GA_3 promoted α-amylase activity, which was further enhanced due to GA_3 combined with kinetin. Reducing sugars content increased as the α-amylase activity was increased. These reducing sugars are used for enhanced development of new cell organelles during cell division for the growth of hypocotyl and epicotyl of embryo, thus enhanced germination after imbibitions (Mozumder *et al.*, 8). Single plant weight and number of leaves were unaffected with different hormone application. Fresh weight of plant per unit area and fresh yield (t/ha) was increased with different hormone treatments and it was higher with mixed hormone treatment. The maximum marketable fresh weight (6.65 kg/m^2) and fresh yield (53.21 t/ha) was obtained from seed treated with GA_3 (500 ppm) and kinetin (50 ppm) (Tables 1&2). Higher fresh yield in hormone treated plots might be the result of enhanced germination and higher number of plants. Higher gross return (Tk. 13,30, 200/ha), net return (Tk. 10,43,500/ha) and benefit cost ratio (BCR) (4.67) were obtained from the mixed application of GA_3 (500 ppm) and kinetin (50 ppm) and it was lower in control (Tk. 8,28,000/ha; Tk. 5,51,000/ha and 2.98, respectively). Higher benefits over control (Tk. 4,92,500/ha, 45.55%) also obtained from the same treatment (Table 2).

The number of plants per unit area was increased with higher seed rates but the rate of germination was decreased with higher seed rates both in hormone treated or untreated plots. Number of pants per unit area was higher (1468/m^2) when 40 kg/ha seed was sown while it was lower (1170/m^2) in 20 kg/ha (Table 1). However, days to germination and leaf size were unaffected with different seed rates. Single plant weight (4.66 g) and number of leaves per plant (6.7) were higher in 20 kg seed/ha and lower (4.27g; 5.8) with 40 kg seed/ha (Table 1). This is due wider space and nutrient availability in lower plant population with reduced seed rates. Fresh marketable plant weight (5.90 kg/m^2) and yield (53.21 t/ha) was higher with 40 kg seed rates but it was statistically similar (5.85 kg/m^2 and 46.81 t/ha, respectively) with 30 kg seed/ha. This result confirmed the reports of Moniruzzaman *et al.* (8) who obtained maximum fresh weight of *Eryngium foetidum* with 40 kg/ha seed rates in the hilly areas of Bangladesh. Gross return was higher (Tk. 11,80,700/ha) in 40 kg seed rate but net return was higher in 30 kg seed/ha (Tk. 8,88,300/ha) and BCR was higher (4.15) in 30 kg seed/ha. Lower BCR and net return in higher seed rates due to high price of seed (Tk.1800/kg) caused higher cost of cultivation with increasing seed rates. On the other hand more profit can be obtained due lower cost of cultivation in lower seed rates.

Number of plants per unit area and fresh yield was significantly differed due to the combined effect of hormone application and seed rate. Maximum number of plants (1,592/m^2) obtained from the mixed application of GA_3 500 ppm and kinetin 50 ppm with 40 kg seed/ha while the lowest (753/m^2) was obtained from the control (without hormone) plot with 20 kg seed/ha (Fig. 1). Days to germination, number of leaves/plant and single plant weight were not significantly differed due to the application of hormone and seed rate. Fig. 2 showed that the fresh weight production were maximum (6.87 kg/m^2) in GA_3 500 ppm and kinetin 50 ppm treated plots with 30 kg seed/ha, which was statistically similar (6.69 kg/m^2) with 20 kg seed/

Table 1. Single effect of seed rate and hormone on plant population and growth of *Eryngium*.

Treatment	No of plants/m^2	Single plant wt. (g)	No. leaves / plant	No. of flower stalks/m^2	Fresh wt. of plant (kg/m^2)	DM (%)
Hormone (ppm)						
Control (T_1)	987b	4.44	6.5a	94.7a	4.14b	14.73a
GA_3 100 (T_2)	1334ab	4.23	6.3ab	89.4ab	5.43ab	13.99ab
GA_3 500 (T_3)	1294ab	4.27	6.6a	91.7ab	5.52ab	13.91ab
GA_3 1000 (T_4)	1364ab	4.83	6.1ab	63.4c	5.78a	13.44ab
Kinetin 10 (T_5)	1398ab	4.33	6.0b	66.0bc	5.98a	13.57ab
Kinetin 50 (T_6)	1461a	4.43	5.8b	98.3a	6.02a	13.25b
Kinetin 100 (T_7)	1398ab	4.58	6.7a	77.3abc	6.19a	14.09ab
Kinetin 50 + GA_3 500 (T_8)	1436a	4.33	6.5a	82.0abc	6.65a	12.95b
Significance	**	NS	*	*	**	*
Seed rate (kg/ha)						
20 (S_1)	1170c	4.66a	6.7a	97.2a	5.39b	14.04
30 (S_2)	1364b	4.36b	6.2ab	80.0b	5.85a	13.64
40 (S_3)	1468a	4.27b	5.8b	71.4c	5.90a	13.54
Significance	**	*	**	*	*	NS
CV (%)	9.34	11.22	12.16	18.68	11.83	8.54

Means followed by same letter or without letter in a column did not differed significantly at 5% level; dm = Dry matter

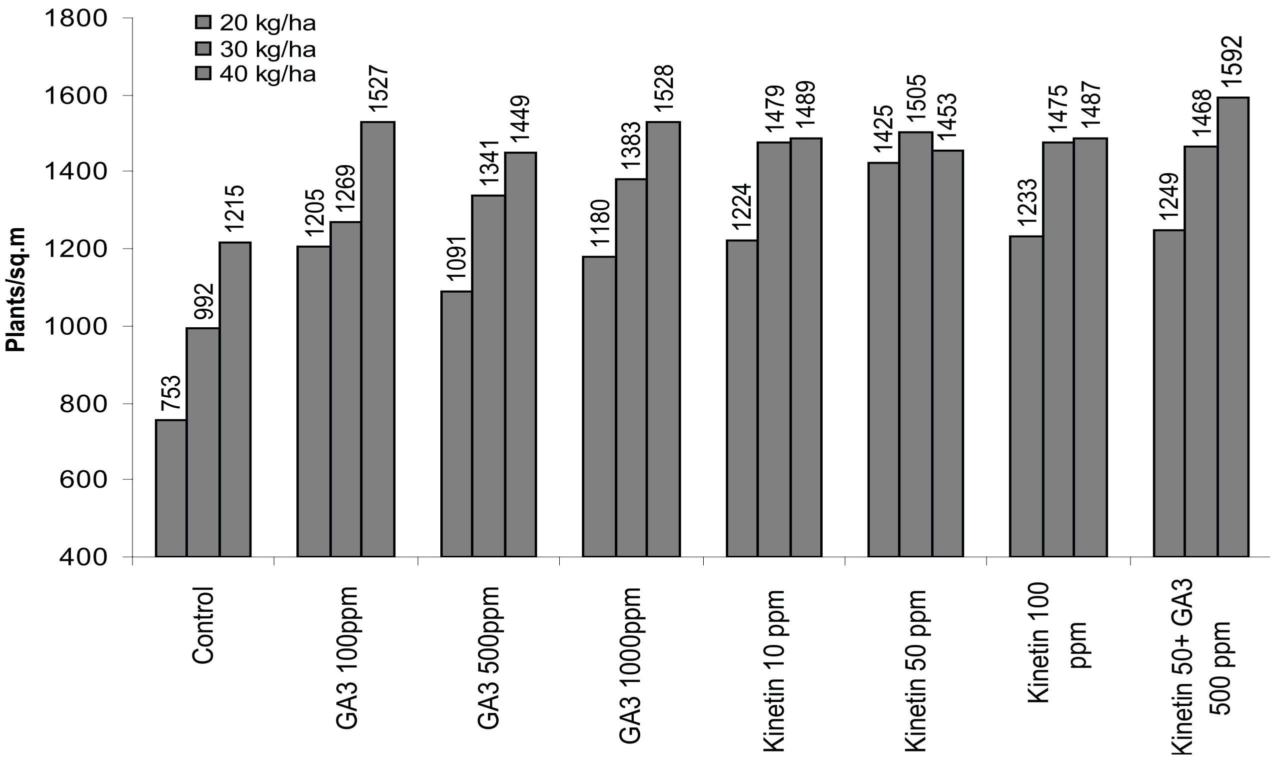

Fig. 1. Effect of hormone and seed rates on number of plant/sq.m in *Eryngium*.

Table 2. Single effect of seed rate and hormone on yield and profitability of *Eryngium*.

Treatment	Fresh yield (t/ha)	Gross return (,000 Tk.)	Net return (,000 Tk.)	Benefit: cost ratio (BCR)	Benefit over control ('000 Tk./ha)	Benefit over control (%)
Hormone						
T_1	33.12b	828.0b	551.0c	2.98b	--	--
T_2	43.42ab	1085.3ab	777.9b	3.87ab	254.1b	29.43b
T_3	44.18ab	1104.6ab	818.6ab	3.85ab	267.6b	31.35b
T_4	46.24a	1156.0a	861.0ab	3.92ab	310.0b	31.16b
T_5	47.87a	1196.9a	918.9ab	4.33a	359.7a	39.56a
T_6	48.19a	1211.6a	924.0ab	4.35a	380.3a	37.51a
T_7	49.54a	1238.7a	960.2ab	4.46a	409.2a	42.24a
T_8	53.21a	1330.2a	1043.5a	4.67a	492.5a	45.55a
Deg. of sig.	**	**	**	**	**	**
Seed rate						
S_1	43.14b	1080.0b	807.1b	4.15	381.9a	40.35a
S_2	46.81a	1171.0a	888.3a	4.14	324.9ab	33.67ab
S_3	47.23a	1180.7a	875.2a	3.87	220.7b	22.28b
Degree of Sig.	**	*	*	*	**	**
CV%	11.28	11.78	12.21	14.24	16.56	19.61

Means followed by same letter or without letter in a column are not differed significantly at 5% level, *,**, significance at 5 and 1% levels. *Gross return: @ Tk 25/kg fresh leaves.

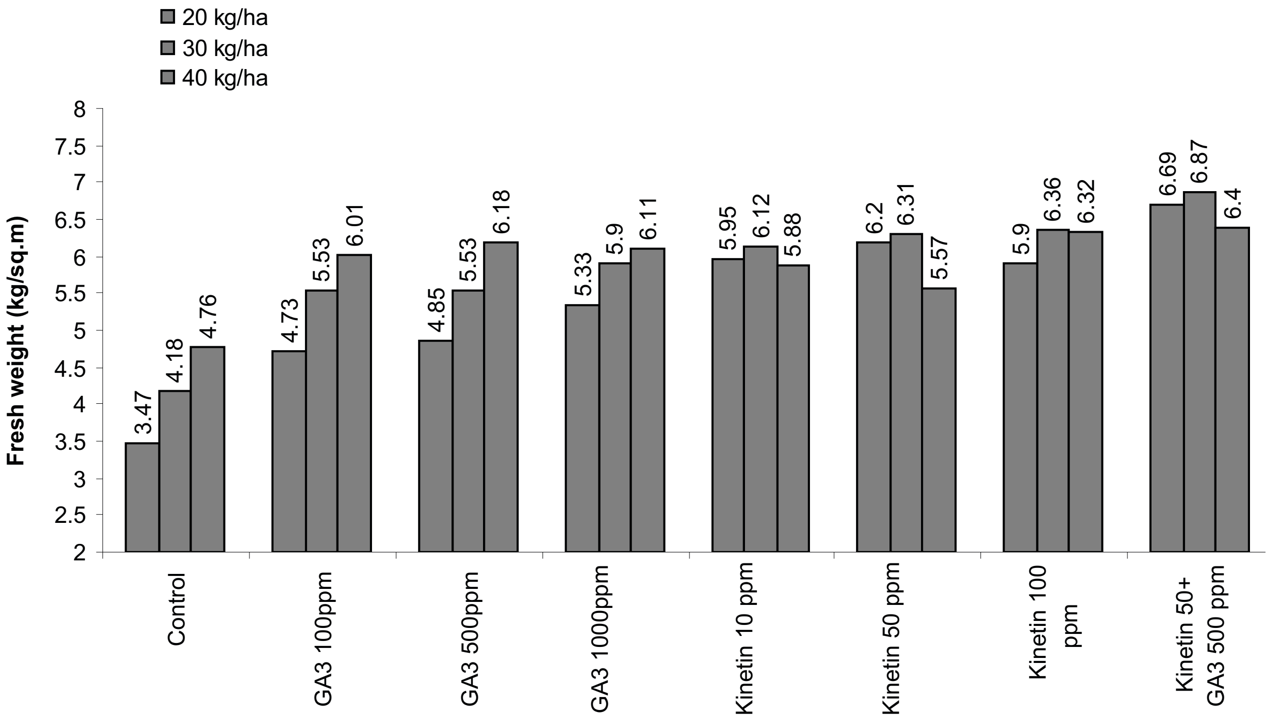

Fig. 2. Effect of hormone and seed rates on fresh weight of *Bangladhonia* plant.

Table 3. Interaction effect of seed rate and hormone on yield and profitability of *Eryngium*.

Treatment	Single plant wt. (g)	Fresh yield (t/ha)	Gross return ('000 Tk.)*	Net return ('000 Tk.)	Benefit:cost ratio (BCR)	Benefit over control ('000 Tk./ha)	Benefit over control (%)
T_1S_1	4.89	27.78g	694.7f	437.7h	2.70h	000.0c	00.00c
T_1S_2	4.41	33.49fg	837.3ef	560.3gh	3.02gh	000.0c	00.00c
T_1S_3	4.02	38.08efg	952.0de	655.0e-h	3.20fgh	000.0c	00.00c
T_2S_1	3.93	37.86d-g	946.7de	588.4fgh	3.67efg	250.8abc	34.33ab
T_2S_2	4.04	44.26a-f	1106.7a-d	826.1b-f	3.94b-f	265.7abc	32.00ab
T_2S_3	4.73	48.10a-e	1202.7a-d	919.3a-d	3.99b-f	245.9abc	21.96abc
T_3S_1	4.24	38.82c-g	970.7cde	707.7d-g	3.69efg	270.0abc	38.29ab
T_3S_3	4.06	44.26a-f	1106.7a-d	820.7b-f	3.87c-g	260.3abc	28.57ab
T_3S_3	4.51	49.46abc	1236.4abc	927.4a-d	4.00b-f	272.4abc	27.21ab
T_4S_1	5.09	42.66b-f	1066.7b-e	797.7c-g	3.97b-f	360.0abc	34.09ab
T_4S_2	5.07	47.20a-e	1180.0a-d	885.0a-e	4.00b-f	324.7abc	34.21ab
T_4S_3	4.34	48.86a-e	1221.3abc	900.3a-e	3.81d-g	245.3abc	25.19ab
T_5S_1	4.12	47.62a-e	1190.7a-d	933.6a-d	4.63a-d	495.9ab	53.84a
T_5S_2	4.52	48.96a-d	1224.0abc	946.8a-d	4.41a-e	362.1abc	40.85ab
T_5S_3	4.34	47.04a-e	1176.0a-d	876.2a-e	3.94b-f	221.1abc	23.97abc
T_6S_1	4.83	49.60ab	1253.3ab	995.8abc	4.87ab	558.2ab	54.24a
T_6S_2	4.17	50.46ab	1268.0ab	987.6abc	5.54a-e	427.3ab	42.75a
T_6S_3	4.28	44.54a-f	1113.3a-d	788.7c-g	3.65efg	155.6bc	15.54bc
T_7S_1	5.25	47.20a-e	1180.0a-d	922.0a-d	4.57a-e	484.3ab	51.33a
T_7S_2	4.54	50.88ab	1272.0ab	993.5abc	4.57a-e	433.2ab	42.93a
T_7S_3	3.59	50.56abc	1264.0ab	965.0a-d	4.23a-e	310.0 abc	32.45ab
T_8S_1	4.95	53.50a	1337.3a	1073.8ab	5.08a	636.2a	56.70a
T_8S_2	4.09	54.94a	1373.3a	1086.5a	4.79abc	526.3ab	48.05a
T_8S_3	3.95	51.20ab	1280.0ab	970.0abc	4.13b-f	315.0 abc	31.89ab
Significance	NS	*	*	*	*	*	*
CV(%)	11.22	11.28	11.78	12.21	14.24	16.563	19.61

Means followed by same letter or without letter in a column are not differed significantly at 5% level, *significance at 5% level, *Gross return: @ Tk 25/kg fresh leaves.

ha in same hormonal treatment. The maximum fresh yield (54.94 t/ha), gross return (Tk. 13,73,300/ha) and net return (Tk. 10,86,500/ha) was obtained from mixed hormone (GA_3 500 ppm + kinetin 50 ppm) application with 30 kg seed/ha, while benefit: cost ratio (5.08), benefit over control (Tk. 6,36,200/ha), percentage of benefit over control (56.7%) were obtained from same hormonal treatment with 20 kg seed/ha (Table 3). Interaction effect of hormone treatment and seed rates showed that the number of plants as well as yield and profitability were higher with higher seed rates (40 kg/ha) in control plots while in hormone treated plots lower seed rates gave the higher yield and benefits. This portion of result kept pace with the report of Moniruzzaman *et al.* (6) who obtained maximum yield of *Eryngium foetidum* with 40 kg seed per hectare without hormone treatment. Application of growth regulator (GA_3 and kinetin) increased seed germination that lower amount of seeds produced sufficient plant stand for better yield as well as profitability. From the basis of the experimental results, the seed rate of *Eryngium* could be considerably reduced from 40 to 20 kg/ha if the seeds are treated with GA_3 (500 ppm) and kinetin (50 ppm) before sowing.

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