J. Sylhet Agril. Univ. 2(2):171-178, 2015 **Research Article** **ISSN: 2308-1597**

EFFECT OF FOLIAR APPLICATION OF GA_3 AND PLANT AGES ON YIELD AND QUALITY OF CARROT SEED

M I Hossain*[1], M M Hossain[2], J Ferdousi[3] and M M Haque[1]

[1]*Senior Scientific Officer, Sylhet Agricultural University, Sylhet-3100, Bangladesh*
[2]*Department of Horticulture, Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur, Bangladesh*
[3]*Department of Horticulture, Sylhet Agricultural University, Sylhet-3100, Bangladesh*

Abstract

A field study was conducted to investigate the effect of foliar application of GA_3 and plant ages on yield and quality of carrot seed. Three different plant ages (20, 30 and 40 days) and four concentrations of GA_3 (0, 100, 200, 300 ppm) were considered as treatments in the study. The design of the experiment was two factorial Randomized Complete Block Design with three replications where three different plant ages (20, 30 and 40 days) were comprised as factor- A and four different GA_3 concentrations (0, 100, 200, 300 ppm) were considered as factor- B. Results showed that plant age of 30 days was found to produce highest seed yield (1152 kg ha^{-1}) followed by 1051 kg ha^{-1} from 40 days plant age while the lowest seed yield (916.6 kg ha^{-1}) was harvested from 20 days plant age. On the other hand, the highest seed yield (1849 kg ha^{-1}.) was obtained from foliar application with 200 ppm GA_3 followed by 300 ppm GA_3 (1267 kg ha^{-1}.). The lowest seed yield (106.2 kg ha^{-1}.) was obtained from the control treatment (no application of GA_3). The highest yield was obtained (2120 kg ha^{-1}) from the plots having effect of 30 days plant age with 200 ppm of GA_3 application. It was statistically/interaction similar to those plots (1924 kg ha^{-1}) of 40 days plant age combined with 200 ppm GA_3 application. The lowest seed yield (102.1 kg ha^{-1}) was harvested from the plots of 20 days plant age without GA_3 treatment. The study revealed that 30 days plant age with foliar application of GA_3 at 200 ppm produced the best quality and the highest seed yield (2.12 t ha^{-1}) in the tropical carrot variety Bejo shetal.

Keywords: Carrot, GA_3 application, seed yield, quality.

Introduction

Carrot (*Daucas carota L.*) is an important and nutritious root vegetable crop. It plays a vital role to protect the blindness of children providing vitamin A. In Bangladesh, there is no recommended variety of carrot for seed production. Many countries have developed good quality high yielding varieties through introduction. For the development of suitable varieties, it is essential to evaluate the characters of the available germplasm properly and conserve the collected materials for future use. Almost entire production of carrot in Bangladesh depends on imported seeds. These are relatively expensive which are not always available in time for sowing. So, cultivation of good quality carrot falls in an uncertainty. This situation also restricts its production. To save the foreign currency and to increase carrot production, timely supply of quality seed in desired quantity should be ensured. This is possible through the improvement of seed production. Hence, the genetic information of different varieties on yield, yield contributing characters and quality of carrot seed producing species are to be assessed for its improvement.

In Bangladesh, the popularity of carrot is increasing day by day for its nutritive value as well as acceptability as a fresh and salad food. Now a days, especially the urban people like it very much for its high nutritive value than cucumber and possible diversified use in making different palatable foods. It is also available in off season due to its long shelf life and less attacked by pest and diseases in storage (Hossain, 2004).

***Corresponding author: M I Hossain,** Senior Scientific Officer, Sylhet Agricultural University, Sylhet-3100, Bangladesh. Email: iqbal081983@yahoo.com*

The production of quality seed at farmers' level is the prerequisite for sustainable agriculture in Bangladesh (Alim, 1974; Hossain, 1993). Still all carrots produced in Bangladesh are grown from imported seed, which do not produce seed in agro-climatic condition of the country. It usually requires relatively low temperature for flowering.

Carrot is widely cultivated in Bangladesh during winter season. Timely supply of quality seeds are not available to the farmers is the main constraint of it extensive production. Seed production of carrot is very specific for its climatic requirements. The climatic condition of Bangladesh is not optimum for exotic European high yielding carrot varieties for seed production. Moreover, a number of popular exotic commercial carrot cultivars are of hybrid types. As such there is no other alternative than to import large quantity of carrot seeds every year, by the expense of hard earned foreign currency. The imported seeds are relatively expensive which are not always available in time for sowing. Hence cultivation of good quality carrot becomes an uncertainty every year. To boost up carrot production in the country and timely supply of quality seeds in desired quantity must be ensured by producing carrot seed locally. Production of carrot seed especially of biennial type is greatly influenced by temperature (Bose and Som, 1986). It is characterized by vegetative growth in the first year followed by reproductive growth after vernalization in the second year. The carrot plant generally requires vernalization for flowering, since even small rooted plants, if vernalized, will bolt and flower. Considering the above facts and observation, the present study was therefore, undertaken to find out the appropriate GA_3 conc. which influences the yield and quality of carrot seed and to know the proper age of plant for GA_3 application.

Materials and Methods

The experiment was conducted at the Horticultural Research Farm of Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur during the period from 30 October 2007 to 5 May 2008. The land was well prepared with the tractor followed by harrowing and laddering for a good tilth. All weeds and stubbles were removed during land preparation. The plots were prepared, drains were made around each plot and the excavated soil was used for raising the plots about 10 cm high. Ridges were made around each plot to restrict the lateral run off of irrigation water. The variety "Bejoshetal" of India was the planting material used for the study. This variety was selected on the basis of performance of previous findings. The two-factor experiment was laid out in the Randomized Complete Block Design (RCBD) with three replications. The whole experimental area was divided into three blocks, representing three replications. The three different plant ages (20, 30 and 40 days) was comprised as factor-A and four different concentrations of GA_3 (0, 100, 200 and 300 ppm) were considered as factor-B. The plots were raised by 19 cm from the ground level. The sowing was done on 30 October to 1st week of November. Seed rate of carrot was 700-1250 gm ha^{-1}. The unit plot size was 2.0×1.0 m having row to row and plant to plant spacing of 25 cm and 40 cm, respectively. The unit plot and blocks were separated by 0.75 cm and 0.75 cm space, respectively. The desired concentrations of gibberellic acid were foliar sprayed on the plants at 20, 30 and 40 days of plant age. The solution was sprayed on the plants with the help of hand sprayer. During the experimental period normal cultivation procedures such as manure and fertilizer application, mulching, weeding, irrigation and others application were followed. Generally the seeds were harvested when green umbel turned to brownish or straw color. When the maturity of the seed was completed then the matured umbels were harvested in a brown paper bag. The harvested umbels with bags were then sundried for better threshing and cleaning. The data were recorded on individual plant basis from the selected plants in respect of the following characters. Thousand seed weight (g), seed yield plant^{-1} (g), seed yield hectare^{-1} (kg), percent germination, Co-efficient of germination (%)**:** Faster germination determinate the better success of seedling establishment under field condition. According to Copland (1976), the co-efficient of germination may be estimated using following formula

$$\text{Co} - \text{efficient of germination } (\%) = \frac{\text{A1+A2+}\cdots\ldots\ldots\ldots\ldots\ldots + \text{AX}}{\text{A1T1+A2T2+}\cdots\ldots\ldots\ldots\ldots\ldots\text{+AXTX}} \times 100$$

Where,

A=Number of seed germinated
T=Time corresponded to A
X=Number of days to final count

Vigor index: Higher values of vigor index indicate the higher speed of germination. According to Copeland (1976), the vigor index is estimated using following formula:

$$\text{Vigor index (\%)} = \frac{\text{Number of seed germination (first count)}}{\text{Number of days to first count}} + \text{—} + \text{—} + \frac{\text{Number of seed germination (last count)}}{\text{Number of days to last count}}$$

The collected data were statistically analyzed and the treatments mean were compared by DMRT (Gomez and Gomez, 1984).

Results and Discussion

Thousand seeds weight (g): Seed size is a parameter of seed quality because bigger seed ensures better seedling establishment in the field. Significant variation was obtained in 1000 seed weight among the plant age of carrot used as planting materials. The maximum 1000 seed weight (2.30 g) was obtained from 30 days plant age which was followed by 2.18 g in plant having 40 days plant age. The minimum 1000 seed weight (2.03) was obtained from 20 days plant age (Table 1).

Table 1. Effects of different plant ages and foliar application of GA_3 with various concentrations on thousand seed weight of carrot.

Plant age(Days)	1000 seed wt.(g)	Seed yield (g plant^{-1})
20	2.031 c	8.15 c
30	2.304 a	10.15 a
40	2.180 b	9.30 b
GA_3 Concentration (ppm)		
Control	1.214 d	3.02 d
100	2.143 c	7.81 c
200	2.744 a	15.41 a
300	2.584 b	10.56 b
Interaction		
G_0A_1	1.023 f	2.91 f
G_0A_2	1.467 e	3.09 f
G_0A_3	1.153 f	3.57 f
G_1A_1	1.873 d	7.53 e
G_1A_2	2.310 c	7.84 e
G_1A_3	2.247 c	8.05 e
G_2A_1	2.727 a	12.53 c
G_2A_2	2.773 a	17.67 a
G_2A_3	2.733 a	16.03 b
G_3A_1	2.500 b	9.63 d
G_3A_2	2.667 ab	11.98 c
G_3A_3	2.587 ab	10.07 d
CV (%)	4.80	5.03

In a column, means followed by common letters are not significantly different from each other at 5% level of probability by DMRT.

There was significant variation in 1000 seed weight which was also evident due to application of different concentrations of GA_3. The highest weight 2.74 g of 1000 seed was found by application of 200 ppm GA_3, which was significantly different and followed by 2.58 g in plants sprayed with 300 ppm of GA_3, 2.14 g in plants with 100 ppm of GA_3. The lowest weight 1.21 g of 1000 seed was obtained in plots where no application of GA_3 was made. It was observed that the application of different concentrations of GA_3 increased the 1000 seed weight compared to those of control (Table 1). Ghoname *et al.* (2004) also found the similar results using 200 ppm of GA_3 and obtained the highest 1000 seed weight of carrot.

The interaction effect of plant age and GA_3 application also significantly influenced the 1000 seed weight of carrot. The highest 1000 seed weight (2.77 g) was recorded in the G_2A_2 treated plots which was statistically similar to those harvested from G_2A_3, G_2A_1, G_3A_2 treated plants but significantly different to those of G_3A_1 treatment combinations. The lowest 1000 seed weight (1.02 g) was recorded in G_0A_1 treatment combinations (Table 1). Bigger size seed and higher weight of 1000 seeds ensure the better quality of carrot seed. It was evident from the Table 1 that 30 days

plant age and 200 ppm of GA_3 increased the quality of carrot seed. Mohanta *et al.* (2008) reported that the combined effect of 30 days plant age and 200 ppm GA_3 gave the highest 1000 seed weight of carrot.

Seed yield plant^{-1}: The carrot seed yields plant^{-1} was significantly influenced by plant age of carrot. The highest seed yield plant^{-1} (10.15 g) was obtained by 30 days plant age followed by 9.30 g those of 40 days plant age. The lowest seed yield plant^{-1} (8.15 g) was found in plots of 20 days plant age (Table 1). From this Table 1 it can be concluded that 20 old plant ages produced the lowest seed yield plant^{-1} than those of 30 days old plant age. The seed yield plant^{-1} was also significantly influenced by the foliar application of GA_3 at different concentrations. The highest seed yield plant^{-1} (15.41 g) was obtained in the plot sprayed with 200 ppm GA_3 which was significantly different from (10.56 g) those of 300 ppm of GA_3 treated plots and (7.81 g) by 100 ppm treated plots of GA_3. The lowest seed yield plant^{-1} (3.02 g) was obtained on plots where no application of GA_3 (Table 1) was made. The result revealed that the seed yield gradually increased over control. It can be concluded that the seed yield plant^{-1} increased due to increased concentration of GA_3 up to 200 ppm and gradually decreased the seed yield plant^{-1} with the increased of GA_3 concentration. The lowest seed yield plant^{-1} were obtained in control plots. Ghoname *et al.* (2004) reported the similar results utilizing 200 ppm of GA_3 and obtained the highest seed yield plant^{-1} of carrot. The interaction effect of plant age and GA_3 application was also significantly influenced by seed yield plant^{-1}. The highest seed yield plant^{-1} (17.67 g) was recorded in G_2A_2 treatment combinations which were significantly differed from 16.03 g in G_2A_3, G_2A_1, treatment combinations. The lowest seed yield (2.91 g plant^{-1}) was recorded in G_0A_1 treatment combinations (Table 1). From this Figure it was also found that combined effect increased the seed yield plant^{-1} gradually up to the 30 days plant age and application of 200 ppm GA_3 and then it decreased when 40 days old plant age and in combination with 300 ppm of GA_3. Mohanta *et al.* (2008) reported that the combined effect of 30 days plant age and 200 ppm of GA_3 gave the highest seed yield plant^{-1} of carrot.

Seed yield hectare^{-1}: Significant variation was observed among different plant ages as planting materials in respect of seed yield ha^{-1}. The highest seed yield (1152 kg ha^{-1}) was obtained in the plots utilizing 30 days plant age which was followed by 1051 kg in plots using 40 days plant age while the lowest seed (916.6 kg ha^{-1}) was obtained in plots of 20 days plant age (Fig. 1). It was evident from the Figure that 20 days old plant age produced the lowest seed yield ha^{-1} and increased plant age increased the seed yield up to 30 days old, whereas 40 days old plant age decreased seed yield hectare^{-1}.

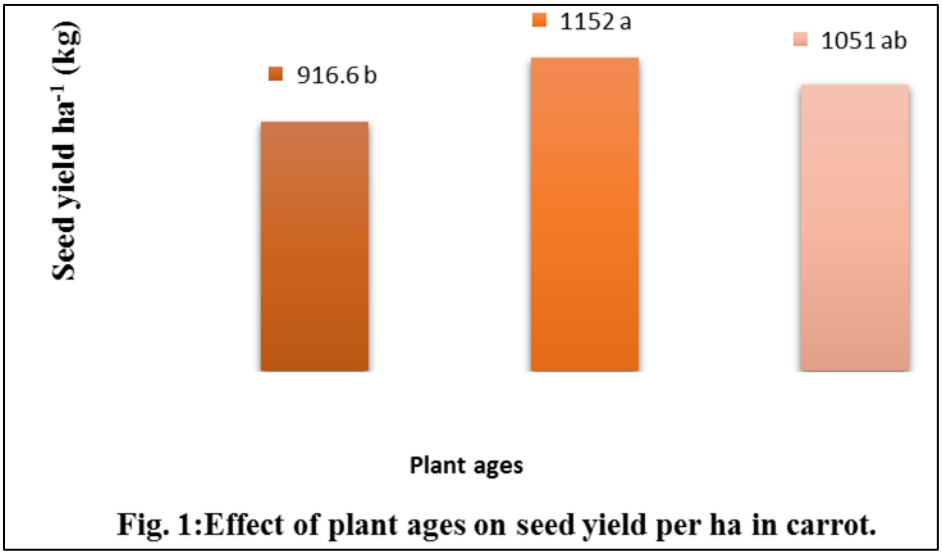

Fig. 1:Effect of plant ages on seed yield per ha in carrot.

Foliar application of GA_3 had significant influence on seed yield ha^{-1}. A wide variation was observed among the different concentration of GA_3 application. The highest seed yield ha^{-1} (1849 kg) was obtained from plots with 200 ppm of GA_3 application which was statistically different from 1267 kg harvested from 300 ppm of GA_3, 937.5 kg in 100 ppm of GA_3 sprayed plots. The lowest seed yield (106.2 kg ha^{-1}) was obtained in the plots with no application of GA_3 (Fig. 2). From this result it might be concluded that GA_3 200 ppm treatment was best seed yielder than the others concentrations of GA_3 in carrot. This result also agreed with the statement of Raymond (1985). Ghoname *et al.* (2004) found the similar results using 200 ppm of GA_3 and obtained the highest seed yield ha^{-1} of carrot.

The interaction between plant age and GA_3 application was also significantly influenced by seed yield ha^{-1}. The maximum seed yield (2120 kg ha^{-1}) was obtained in plot treated with G_2A_2 which was statistically similar to that of the plots having G_2A_3 treatment and differed from the plots of G_2A_1, G_3A_2 and rest of the treatment combinations. The lowest seed yield (102.1 kg ha^{-1}) was obtained in plots of G_0A_1 treatment combinations (Fig. 3). Mohanta *et al.* (2008) reported that combined effect of 30 days plant age and 200 ppm of GA_3 gave the highest seed yield ha^{-1} of carrot.

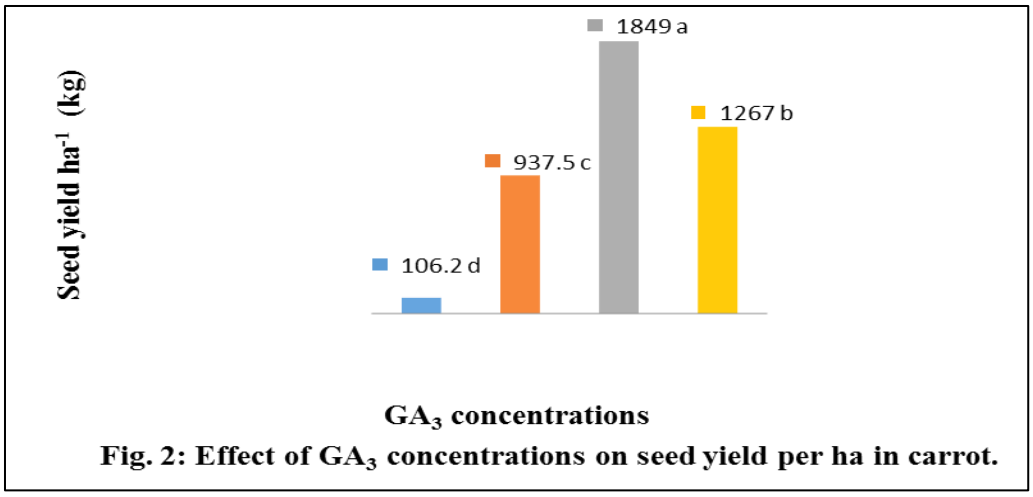

Fig. 2: Effect of GA_3 concentrations on seed yield per ha in carrot.

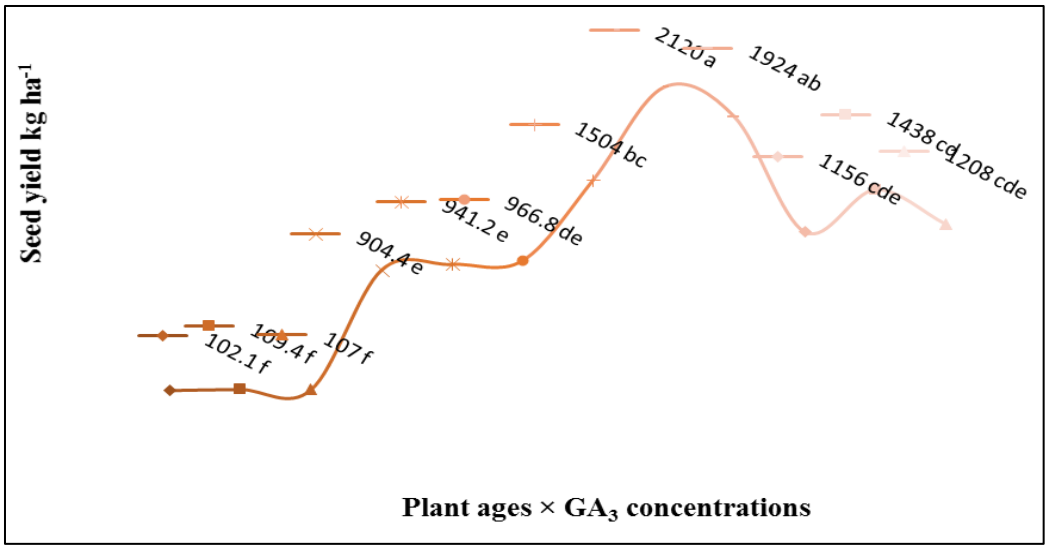

Fig. 3. Interaction effect of plant ages and GA_3 concentrations on seed yield ha^{-1} in carrot.

Germination (%): Germination capacity is the major indicator of seed viability. Satisfactory crop establishment depends on some other associated factors like seed vigor and field condition. The seed having lower or minimum vigor value cannot germinate well under field condition and also do not help in crop establishment. Low rate of germination indicates the low vigor of seeds.

The percentage of germination varied significantly with plant age. The highest percent of germination (78.28%) was exhibited by 30 days plant age which was statistically similar to 77.44% which germinated from the seed of 40 days plant age. The lowest percent of germination (68.45%) was observed in the seed of the plots of 20 days plant age (Table 2). It may be concluded that the seed obtained from plots of 30 and 40 days plant age were superior in quality than that of 20 day plant age.

The germination percent of seed was significantly influenced by the foliar application of GA_3. The highest percent of germination (93.0%) was observed in seeds of 200 ppm GA_3 applied plot which was followed by 82.82% from seed of the plots of 300 ppm of GA_3 and 75.75% from 100 ppm of GA_3 sprayed plot. The lowest germination percentage (47.31%) was observed in seed from plots with no application of GA_3 (Table 2). Ghoname *et al.* (2004) found the similar results from seeds harvested from 200 ppm of GA_3 treated plots and found the highest germination percentage of seed.

Table 2. Effect of various plant ages and different foliar concentrations of GA_3 on seed quality of carrot.

Plant age (Days)	Germination (%)	Co-efficient of germination	Vigor index
20	68.45 b	16.72 b	3.051 c
30	78.28 a	20.21 a	4.391 a
40	77.44 a	19.58 a	3.885 b
GA_3 Concentration (ppm)			
Control	47.31 d	7.636 d	1.727 d
100	75.75 c	19.40 c	3.479 c
200	93.00 a	26.13 a	5.523 a
300	82.82 b	22.19 b	4.373 b
Interaction			
G_0A_1	39.62 f	7.723 d	1.633 e
G_0A_2	51.65 e	7.540 d	1.897 e
G_0A_3	50.68 e	7.643 d	1.650 e
G_1A_1	63.81 d	14.64 c	2.307 e
G_1A_2	81.63 c	21.89 b	4.040 cd
G_1A_3	81.81 c	21.67 b	4.090 cd
G_2A_1	88.54 bc	23.10 b	4.131 cd
G_2A_2	96.53 a	28.98 a	6.773 a
G_2A_3	93.93 ab	26.31 a	5.523 b
G_3A_1	81.81 c	21.43 b	3.950 d
G_3A_2	83.33 c	22.44 b	4.893 bc
G_3A_3	83.33 c	22.69 b	4.277 cd
CV (%)	5.70	8.51	12.16

In a column, means followed by common letters are not significantly different from each other at 5% level of probability by DMRT.

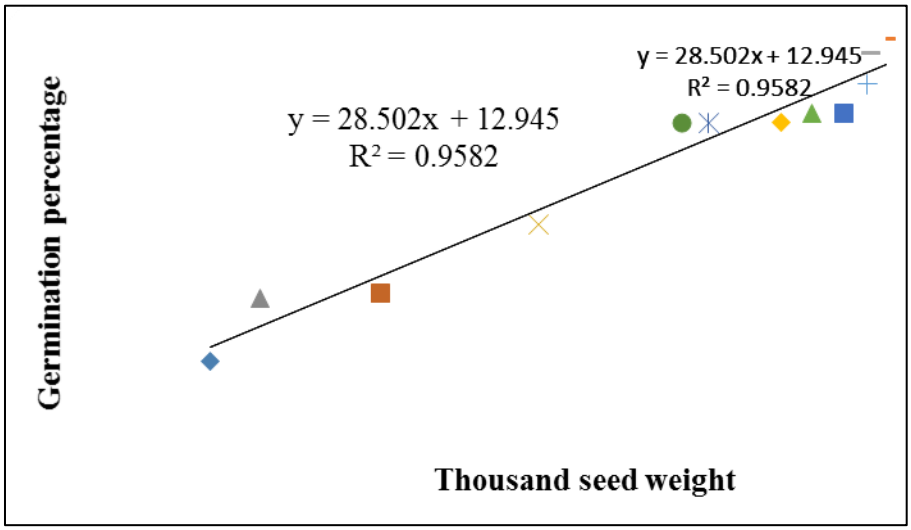

Fig. 4. Relationship between 1000- seed weight and germination percentage of carrot seed.

The interaction effect of plant age and GA_3 application was also significantly influenced by germination percent. The highest germination percentage (96.53%) was recorded in seeds of G_2A_2 treated plots which were statistically similar to 93.33% from seed of G_2A_3 applied plots. The lowest germination percentage (39.62%) was recorded from the seed of G_0A_1 treatment combinations (Fig. 4). Mohanta *et al.* (2008) found the combined effect of 30 days plant age and 200 ppm GA_3 gave the highest seed germination percentage.

Co-efficient of germination (%): Higher values of co-efficient of germination indicate the higher speed of germination. On the other hand, faster germination determinates the better success of seedling establishment under field condition. Significant variation was observed in co-efficient of germination due to the application of different concentrations of GA_3 and use of different plant ages. The highest co-efficient of germination (20.21%) was exhibited in 30 days plant age as planting material which was statistically similar to 19.58% with 40 days plant age. The lowest co-efficient of germination (16.72%) was observed in 20 days plant age (Table 2). It may be concluded that the seed obtained from 30 days plant age treated plots were superior in quality than the other plant ages in respect of co-efficient of germination. The co-efficient of germination was also significantly influenced by the foliar application of different concentrations of GA_3. The highest co-efficient of germination (26.13%) was found in 200 ppm GA_3 application which was followed by 22.19% in 300 ppm of GA_3 and 19.40% in 100 ppm of GA_3. The lowest co-efficient of germination (7.63%) was observed in seeds of the plot where no application of GA_3 was made (Table 2). It may be concluded that no application of GA_3 reduces the co-efficient of germination of carrot seed. The highest co-efficient of germination value indicates the better quality of seed. Mohanta *et al.* (2008) found the similar results with 200 ppm of GA_3 application and obtained the highest co-efficient of germination of carrot seed.

The interaction effect of plant age and GA_3 application also significantly influenced the co-efficient of germination. The highest co-efficient of germination (28.98%) was recorded in G_2A_2 treatment combinations which was statistically similar to 26.31% in G_2A_3 treatment combinations. The lowest co-efficient of germination (7.54%) was recorded in G_0A_2 treatment combinations (Fig. 5). Mohanta *et al.* (2008) found the combined effect of 30 days plant age and 200 ppm GA_3 which showed the highest co-efficient of germination.

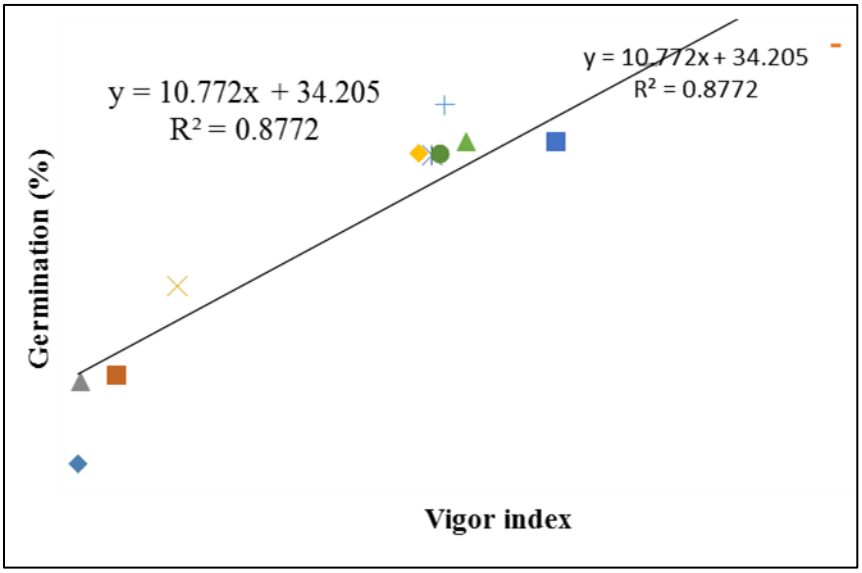

Fig. 5. Relationship between vigor index and germination percentage.

Vigor index: Higher values of vigor index indicate the higher speed of germination. The vigor index was significantly influenced by plant age. The highest vigor index (4.39) was observed in plots with 30 days plant age followed by 3.88 g in 40 days plant age and the lowest vigor index (3.05) was found in 20 days plant age (Table 2).

The vigor index was significantly influenced by foliar application of GA_3 concentration. The maximum vigor index (5.52) was exhibited in plots with 200 ppm of GA_3 which was followed by 4.37 in 300 ppm of GA_3 and 3.48 in 100 ppm GA_3. The minimum vigor index (1.72) was exhibited in plot without application of GA_3 (Table 2). Mohanta *et*

al. (2008) found the similar results using 200 ppm of GA_3 application and obtained the highest vigor index of carrot seed.

The interaction effect of plant age and GA_3 application was also significantly influenced by vigor index. The highest vigor index (6.77) was found in G_2A_2 treatment combinations which were significantly different from that of G_2A_3, G_3A_2 and the other treatment combinations. The lowest vigor index (1.63) was observed in G_0A_1 treatment combinations (Table 2). Mohanta *et al.* (2008) found the combined effect of 30 days plant age and 200 ppm GA_3 application and obtained the highest vigor index of carrot seed.

Relationship between the thousand seed weight and germination percentage: A positive relationship between the thousand seed weight and germination percent was found to be linear (Fig. 4). It was evident from the Fig. 4 that the equation of $y = 28.50X + 12.94$ gave a good fit to the data and the value of co-efficient of determination ($R^2 = 0.958$) and showed that the fitted regression line had a significant regression co-efficient. So it indicated that the germination percent of carrot seed increased with the increase of seed size and weight.

Relationship between the vigor index and germination percent: A positive relationship between vigor index and germination percentage was found (Fig. 5). The equation $y = 10.77X + 34.20$ gave a good fit to the data and co-efficient of determination ($R^2 = 0.877$) and showed that the best fitted regression line had a significant regression co-efficient. It indicated that the germination percent increased with the increase in vigor index value. Yamarchi and Tun (1996) also observed the positive correlation between vigor index and germination of rice seed and suggested that faster germination determines the success of stand establishment under field condition. The present results concluded that, the best quality and the highest seed yield was obtained (2.12 t ha^{-1}) from the combined effect of 30 days plant age with foliar sprayed 200 ppm of GA_3 application in the tropical carrot variety, Bijo Shetal.

References

Alim A. 1974. An Introduction to Bangladesh Agriculture. First Edition, M. Alim, Dhaka, 9p.

Bose T K and Som M G. 1986. Vegetables in India. Naya Prakash, Calcutta-700006, India. pp.90-91.

Ghoname A A, Shafeek M R and Mahmoud A R. 2004. Effect of seed production method on the productivity and quality of carrot seeds. Arab Univ. J. Agril. Sci. 2004. 12(2): 711-719.

Gomez K A and Gomez A A. 1984. Statistical Procedures for Agricultural Research. (2nd Ed. John Willey & Sons, New York. 680p.

Hossain A K M A. 1993. Importance of vegetables as food security and nutrition, Intensive Vegetable Growing and its utilization. Ed. United States Agency for International Development. p.10.

Hossain M M. 2004. Seed production of onion and carrot. Lecture notes presented in postgraduate Program. Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur-1706.

Mohanta H C. 2008. Effects of genotypes growth regulators and micronutrients on the seed production of the tropical carrot (*Daucas carrot* L.). Ph.D. Thesis. Dept. Hort. Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur.

Raymond A T G. 1985. Vegetable seed production. First edition, Longman publishing group Ltd. 318p.

Yamauchi M and Tun W. 1996. Rice seed vigor and seedling establishment in anaerobic soil. Crop Sci. 36:680-686.