Research Article

Response of Cabbage Cultivars to Different Concentrations of Gibberellic Acid

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Abstract | The experiment was carried out at Pakistan Agricultural Research Council, National Tea and High Value Crops Research Institute Shinkiari, Mansehra during the season of 2018. There were two cabbage cultivars (Asha and Red) and four concentrations of Gibberellic acid (GA_3) (0, 20, 40 and 60 ppm). Experiment was laid out on Randomized Complete Block Design (RCBD) with three replications. Data showed a significant difference among most of the growth parameters. Maximum head weight (2306.7 g), stem length (42.66 cm), number of leaves plant^{-1}(15.73cm), root length (27.53 cm), yield (55.63 t/ha) was recorded for cultivar cabbage red with the application of 60ppm of GA_3.

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Introduction

Cabbage (*Brassica oleracea* var. *capitata* L.), belongs to the family Cruciferae. It is one of the most popular vegetable throughout the world due to its nutritive and culinary use. It was originated in the Denmark, north-western part of France and sea coast of England (Thompson and Kelly, 1957). According to categorization cabbage is included in biennial crops but generally grown as annual crop. In Pakistan, during 2014-15, total area under cabbage cultivation was 4983ha with the production of 77233 tones whereas, in Khyber Pakhtunkhwa during 2014-15 area under cultivation was 605ha with the production of 5219 tons.

Cabbage is a rich source of essential amino acid, tryptophan and vitamin C (Rashid, 1993). According to FAO record at least 5% calories meet is from fruits and vegetables, which may fulfill the human requirement of minerals and vitamins. It has been recorded that 100g edible portion of cabbage contains 24 calories of food, water 92%, carbohydrate 9.8g, calcium (Ca) 40mg, protein 1.5g, Iron (Fe) 0.6mg, thiamine 0.05 mg, carotene 600 IU, niacin 0.3 mg, vitamin E 60 mg and riboflavin 0.05 mg (Rashid, 1993).

In addition to nutrients, small amount of growth regulators is proficient in altering the growth (Leopold, 1963). Plant growth regulators are playing an important role to modify plant growth, development and physiological processes (Dharmender et al., 1996). It was examined that in most of the plants after a minute application of GA_3, cabbage started quick and

efficient growth (Islam et al., 1993). Morphological characters like plant growth, plant height, Number of leaves, head diameter and yield are stimulated by the application of GA_3.

Due to the environmental conditions, application of GA_3 plays a very important role by reducing the transplanting shock from nursery to main field. GA_3 helps the plants in establishing and encouraging the quick growth (Chhonkar and Jha, 1963). Present study was carried out to find out the impact of different concentration of GA_3 on the growth characters and yield of cabbage.

Materials and Methods

The experiment was conducted at National Tea and High Value Crops Research Institute Shinkiari, Mansehra to study the "Response of cabbage cultivars to different concentration of GA_3" during the season of 2018. Two Cabbage cultivars (Asha and Red) were selected to run the experiment treated with four different concentrations levels (G_1-0 ppm; G_2-20 ppm; G_3-40 ppm; G_4- 60 ppm) of GA_3 through foliar application. Nurseries of both the cabbage cultivars were raised on flat beds each having size of 5m×1m. At the time of transplantation experimental site were well ploughed and leveled. The experiment was laid out on a randomized complete block design (RCBD) with three replications. One month old healthy and uniform seedling of cabbage cultivars were transplanted in to main experimental site. GA_3 was sprayed two time after the transplantation of the seedling in to main field, once after the 30 days of transplantation and secondly at the time of flowering.

Statistical analysis

The experimental data obtained for various parameters were statistically analyzed to find out significance of different levels of GA_3 for cabbage growth and yield. The means and least significance difference (LSD) value of all the selected parameters were evaluated by using STATISTIX software at 5% level of significance (Steel and Torrie, 1980).

Results and Discussion

Days to head flowering and maturity

Data regarding days to head flowering and head maturity showed significant difference for cultivars and different concentration of GA_3. Maximum number of days to head flowering (61.66) was recorded for cultivar Cabbage Red with control treatment while the minimum (40.66) number of days to head flowering were recorded for cultivar Asha treated with 60ppm of GA_3. Likewise, maximum number of days to head maturity (76.33) was observed for cultivar Cabbage Red by the application of 40ppm GA_3, whereas minimum days (68.66) were observed for the cultivar cabbage Red by the application of 60ppm of GA_3. Data presented in Table 1 also showed the significant variation for head diameter (cm). Maximum diameter (60.46 and 59.66 cm) was measured for cultivar Cabbage Red and Asha respectively when treated with 60ppm of GA_3 while minimum head diameter (50.86 cm) was observed for cultivar Asha in control treatment, followed by cultivar Cabbage Red (53.80 cm) and Asha (53.50 cm) treated with control and 20ppm of GA_3 respectively. Our results are in close agreement with the conclusions of (Roy and Nasiruddin, 2011), they reported that days to flowering and maturity decreases with the increase of GA_3 concentration up to 75ppm.

Head weight (g)

Data regarding head weight for both the cultivars was influenced by GA_3 Concentration, maximum head weight (2306.7 g) was recorded for cultivar Red by the application of 60ppm of GA_3, while minimum head weight (1483.3 g) was recorded for cultivar Asha in control treatment. The variation in head weight is due to the GA_3 application by the synthesis of new enzymes which are associated with the motivation of RNA synthesis, GA_3 is also involved in the alteration and formation of cell component (Booji, 1989).

Stem length (cm)

Table 1 shows that stem length showed significant difference between cultivars and GA_3 concentration, highest stem length (42.66 cm) were recorded for cultivar Red by the application of 60ppm of GA_3, closely followed by (41.40 cm) for same cultivar by the application of 40ppm of GA_3, while lowest stem length (26.33 cm) were recorded for cultivar Asha in control treatment. The GA_3 is normally used for cell elongation and growth promotion of the plants. Results showed that by the application of GA_3 concentration up to 60ppm promoted the plant growth by increasing the stem length (Reddy, 1989).

Table 1: *Days to head flowering, days to head maturity, head diameter (cm), head weight (g) and stem length (cm) in cabbage as affected by cultivars and different concentrations of GA_3.*

Cultivar	GA_3 Treatments (ppm)	Days to Head Flowering	Days to Head Maturity	Head Diameter (cm)	Head Weight (g)	Stem Length (cm)
Asha	00	53.33c	68.66d	50.86f	1483.3g	26.33e
	20	48.66e	68.33d	53.50e	1610.0f	35.30d
	40	46.33f	74.66b	57.80c	1860.0d	36.86d
	60	40.66g	68.66d	59.66ab	1940.0c	38.46c
Cabbage Red	00	61.66a	75.00ab	53.80e	1760.0e	35.33d
	20	56.00b	71.00c	55.50c	1876.7d	41.06b
	40	50.33d	76.33a	58.86b	2146.7b	41.40ab
	60	46.33f	68.66e	60.46a	2306.7a	42.66a
$LSD_{at: 0.05}$		1.522	1.397	0.932	52.34	1.568

Means not followed by the same letters differ significantly at 5% probability.

Number of leaves plant^{-1}

Data regarding number of leaves showed significant difference for cultivars and GA_3 concentration as presented in Table 2. Maximum number of leaves plant^{-1} (15.73) was observed for cultivar Red by the application of 60ppm of GA_3 whereas minimum number of leaves plant^{-1} (11.10) was observed for cultivar Asha in control treatment. Our results are in close agreement with the findings of Roy and Nasiruddin, 2011, who noticed the maximum number of leaves at 50ppm of GA_3 while minimum for control treatment.

Table 2: *Number of leaves plant^{-1}, root length (cm), stem diameter (mm) and yield (t/h) in cabbage as affected by cultivars and different concentrations of GA_3.*

Cultivars	GA_3 Treatments (ppm)	No. of Leaves Plant^{-1}	Root Length (cm)	Stem Diameter (mm)	Yield (t/ha)
Asha	00	11.10f	20.66e	36.63cd	35.77g
	20	12.56e	21.96cde	40.30b	38.83f
	40	13.13d	22.76c	41.30b	44.85d
	60	13.86c	23.33bc	46.83a	46.78c
Cabbage Red	00	13.20d	21.33de	32.63e	42.44e
	20	14.36b	22.66cd	34.86de	45.25d
	40	14.70b	24.50b	36.13cd	51.77b
	60	15.73a	27.53a	37.66c	55.63a
$LSD_{at: 0.05}$		0.335	1.432	2.363	1.261

Means not followed by the same letters differ significantly at 5% probability.

Root length (cm)

Root length was significantly influenced by cultivars and application of GA_3 as shown in Table 2. Longest root length (27.53 cm) was measured for cultivar Red by the application of 60ppm of GA_3, whereas shortest root length (20.66 cm) were measured for cultivar Asha, closely followed by cultivar Cabbage Red (21.33 cm) without any application of GA_3. These results are similar to the observation of Roy and Nasiruddin, 2011.

Stem diameter (cm)

Stem diameter of cabbage was significantly influenced by the application of GA_3 as well as cultivars as presented in Table 2. The thickest (46.83 mm) stem diameter was observed for cultivar Asha when treated with 60ppm of GA_3 whereas the thinnest (32.63 mm) was observed in control (0.0). Our results are similar with the findings of Roy and Nasiruddin, 2011, who reported that the thickest stem was obtained by the application of high concentration of the GA_3.

Yield (t/h)

Table 2 shows that data regarding yield (t/h) was significantly affected by the application of GA_3 and cultivars. Maximum yield (55.63 t/h) was recorded, for cultivar Red treated with 60ppm of GA3 followed by 51.77 t/h with the application of 40ppm of GA_3. While the minimum yield (35.77 t/h), followed by (38.83 t/h) was recorded for cultivar Asha by the application of Control (0.0) and 20ppm of GA_3, respectively. Our results are in line with the findings of Roy and Nasiruddin, 2011, they observed that the maximum yield of cabbage was obtained by the application of GA_3.

Conclusions

The experimental results indicated that cultivar Red gave the superior results by the application of 60 ppm

of GA_3 concentration as compared to cultivar Asha. The investigated results showed that head weight, stem length, number of leaves plant^{-1}, root length and yield (t/ha) were significantly increased due to the effect of GA_3 compared to control. The gainful production of cultivar cabbage red by the application of 60ppm of GA_3 under the agro-climatic condition of Mansehra is more effective for the better growth, development as well as quality curd production of cabbage.

Author's Contribution

Naveed Ahmed, Abdul Waheed, Farrukh Siyar Hamid and Imtiaz Ahmed designed the study, conducted the experiments and analyzed the experimental data. Muhammad Abbas Khan, Sohail Aslam and Muhammad Adil Younis provided technical assistance at each step and revised the article. Seemab Ali, Nadia Khan and Madiha Bashir helped in data collection and compilation.

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