Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2017; SP1: 188-194

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Effect of nitrogen, naphthalene acetic acid and Gibberellic acid on growth, yield and quality of broccoli (*Brassica oleracea* var. italica L.) Cv. 'Sante'

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Abstract
The experiment was laid out in RBD with three replications, at the Udai Pratap Autonomous College, Varanasi during the year 2013-14. The treatments used were i.e. nitrogen 0, 1 and 2 % NAA in 60 and 120 ppm and Gibberellic acid 0%, 50 and 100 ppm concentrations. Nitrogen at 1.0 and 2.0% improved the vegetative growth attributes of broccoli plant recorded in terms of the height of the plant, length of the root, number of outer leaves, total number of leaves per plant, fresh weight and dry weight of the plant at all the three stages (after 30, 60 and 90 days) of observation. Maximum diameter (19.35 cm), fresh weight of curd (1432.75g), yield (421 q/ha) and ascorbic acid content (24.68 mg/100g) were recorded at 2.0% nitrogen, 120 ppm (N_2A_2) and 100 ppm GA (G_2). In first order interaction, combination of nitrogen with NAA gave better response as compared to nitrogen with GA and NAA with GA combination and in two/three factor combinations, maximum values were under N_2NA_2, $N_2NA_2G_2$ i.e. (19.88cm), fresh weight (1520.40g), yield (454.41q/ha) and ascorbic acid content (26.22mg/100g) of the curd. The application of nitrogen at 2.0%, NAA at 120 ppm and GA_3 at 100 ppm are recommended for better growth, yield and quality of broccoli.

Keywords: Broccoli, NAA, GA, Ascorbic acid, Nitrogen and Curd.

Introduction
Broccoli (*Brassica oleracea* var. italic; family: *Brassicaceae*) is also known as 'green gobhi', is an important vegetable crop. 'Broccoli' the word derives from Latin word 'Brachium' meaning arm of branch being a native of Italy. It contains high level of vitamins, proteins, and minerals beneficial to human health (Lisiewska and Kmiecik; 1995). The word broccoli, from the Italian plural of broccoli, refers to the "flowering top of a cabbage". Broccoli is related to cabbage, kale cauliflower, and Brussels sprouts. Broccoli has large flower heads, green in color, arrange in a tree-like structure on branches sprouting from a thick, edible stalk. Boiling broccoli reduces the levels of suspected anti-organic compounds such as sulforaphane. However, other preparation methods such as stemming, microwaving, and stir-frying had no significant effect on the compounds. Broccoli has the highest levels of carotenoids, in the brassicaceae family, it is particularly rich in beta-carotene.

It is a cool-weather crop that grows poorly in hot summer weather, grows best when exposed to an average daily temperature between 18 and 23 °C (64 and 73 °F). Broccoli should be harvested before the flowers on the head bloom bright yellow. Nitrogen has a pronounced effect of growth and yield of the broccoli plants. It is a constituent of all proteins, which are active component of protoplasm and chlorophyll. Nitrogen is more likely to be the limiting factor than phosphorus and potash. It is one of the elements in the structure of the protein molecules as well as in purines and pyrimdines, porphyrins and co-enzymes. Puriens and pyrimdines are found in the nucleic acid, RNA and DNA, essential for protein synthesis. In absence of nitrogen, buttoning appears in cauliflower, where plants develops small curd or buttons. Pant and Kedar (1980) [10] reported that nitrogen at 50-100 kg/ha result best plant growth and highest yield of cauliflower cv. Snowball-16 than the control. Roy (1981) [12] in cauliflower cv. Dania, it was observed that plants receiving nitrogen at 50-200 kg/ha increased the size of curd and yields. Naphthalene acetic acid (NAA) is an organic compound. This colorless solid is soluble in organic solvents. NAA is synthetic plant hormone in the auxin family and is an ingredient in many commercial plant rotting horticultural product, it is rooting agent is use for vegetative propagation of plants, from stem and leaf cutting, plant tissue culture. NAA has been shown to greatly increase cellulose fiber formation in plants when paired with another phytohormone called gibberellic acid.

Because it is in the auxin family it has also been understood to prevent pre mature dropping and thinning of fruits from stems. It is applied after blossom fertilization. NAA present in environment undergoes oxidation reactions with hydroxyl radicals and sulphate radicals. A radical reaction of NAA was studied by using pulses radiolysis technique.

The growth substance like Naphthalene Acetic Acid (NAA) affects plants very much it may be useful in regulation of growth development and flowering of plant and also involved in biosynthetic process of plant and works with enzymes. The application to NAA affected the physiological processes particularly respiration and photosynthesis, which ultimately lead to accumulation of dry matter, minerals and carbohydrates. Mishra *et al*. (1984) [8] reported that single spray of NAA 100 ppm with 0.2% zinc, one month after transplanting increased vitamin c content and yield of cauliflower. GA stimulates the cell of germinating seeds to produced mRNA molecules that code for hydrolytic enzymes. It is usually used in concentrations between 0.01 and 10 mg/l. Gibberellic acid increases fresh and dries weight leaves and curd of cauliflower in association with NAA and Molybdenum. The growth of tomato seedling (as plant height, fresh and dry weight of plant) has been stimulated by the application of GA and promalin. (Avetisona and Maryakhina, 1987; Singh *et al*., 2015) [16].

Materials and Methods

The proposed work was planned in RBD, plot size - 2.25×3.00 sq. mt., main irrigation channel-1m, sub-irrigation channel - 0.50 m, no. of replication- 3, no. of treatment combinations-27, total no. plots – 81, replication border - 0.75 m, path between plots - 0.25 m, border - 1 m, length of field - 70.25 m, width of the field - 14.5 m. at the vegetable research farm and the research farm of the Department of Horticulture, Udai Pratap Autonomous College Varanasi (U.P.) during the year 2013-2014. The city, Varanasi, experimental plot lies under subtropical zone between $25^0$18' North latitude and 80^0 03' East longitudes. It is of an elevation of about 128.29 meters above the sea level, almost the centre of Indo-genetic belt. The average rainfall in this area is about 1100mm, most of usually during the rainy season. On the basis of climatic condition prevailing in this part of country the entire year could be divided by into three parts: Rainy season – Middle of June to middle of October, winter season - middle of October, February and summer season – Middle of February to Middle of June. A homogeneous piece of land was selected from the composition block of the vegetable research field having an even topography with irrigation and drainage facilities. First ploughing of was done with disc plough followed by the other ploughings with cultivar in order to pulverise the soil. A basal application of FYM @ of 20 tonnes/hectare was used before one month of transplanting.

A healthy certified seed of cauliflower was procured from National Seed Corporation Branch Varanasi. Raised nursery beds of 4m × 1m in size were prepared. The fertilizer application was done area wise @ 50 kg of Nitrogen, 60 kg of Phosphate and 40 kg of Potassium per hectare just before after the transplanting in form of basal placement at 5 to 7 cm deep on both sides of rows. Another does of 50 kg Nitrogen per hectare top dressed after 50days of transplanting. The transplanting distance was 45×60 cm, thus in each plot 27 plants were accommodated. The solutions were prepared for spraying, 10.0 g of N, 50 mg of GA and 60 mg NAA were weighed and dissolved required amount of water separately. By making the volume 1000 ml in a measuring flask, by adding distilled water, the solution of 1.0%, 50 ppm and 60 ppm of nitrogen, gibberellic acid and NAA respectively, were prepared. Thus, for the next required concentrations, 20.0 g nitrogen, 100 mg gibberellic acid and 120 mg NAA were weighed and 2%, 100 ppm and 120 ppm of nitrogen, gibberellic acid and NAA respectively were prepared in the same way. These solutions of different concentrations were sprayed by hand sprayer to wet both surfaces of the leaves. All the treatments were sprayed three times on cauliflower, cultivar first after 15 days of transplanting of seedlings, second after 30 days of transplanting and third spraying 60 days of transplanting. About 10 ml solution was enough for a plant at the time of first spraying, 20ml solution was enough of second spraying and 30 ml solution for third spraying. Nine plants were selected randomly in each plot, tagged and numbered. Various growth characters namely plant height (cm), number of outer leaves per plant, total number of leaves per plant, root length (cm), diameter of curds (cm), average fresh weight of plant (g), of randomly selected, dry weight of plant (gm.), weight of curd (gm.), yield (q/ha), moisture percentage (%), estimation of Ascorbic Acid (mg/100gm) of numbered and tagged plants were observed and data were recorded at 30, 60 and 90 DAS. The estimation of ascorbic acid was accomplished by the lodometric method. 10cc of leaf juice of each treatment was titrated against N/100 Iodine solution using starch as indicator. The Ascorbic Acid contain was calculated in mg/100gm of the juice taken. The statistical analysis had accomplished to find out differences in treatment effects. The results were interpreted on the basis of "F" (Fisher test) and critical differences (C.D.) between different means. Approximate standard error along with critical differences whatever needed have been given.

Results and Discussions

The absorption of aqueous solution of nutrient and PGR generally take place through the stomata as well as cuticle of leaves. Application of these chemicals for foliar for are readily absorbed and Trans located to all part of plant. Nitrogen played in very significant role in the growth and quality of cauliflower (2%). It is required in large amounts and is the most universally deficient element. N influence favourably the root length, height of plant, no. of leaves their fresh weight and dry weights, fresh weight of curd and the quality of cauliflower (Gopal Lal; 1996) [5]. In cauliflower that nitrogen increase the plant height, No. of leaves, steam diameter and yield. This is due to nitrogen initiates meristamatic activity, increases leaves area and total foliage, thereby increasing the assimilation surface leading to a greater production and accumulation of photosynthetic product (Sharma *et al*. 1978; Mangal *et al*. 1982) [7]. According to Patil (1979) the foliar spray of nitrogen (2%) gave significant effect on growth on cauliflower (Reddy 1989) [11]. In absence of N, the plants do not develop normally (i.e. stunted growth) and leaves remain small and do not cover the developing curd. According to these biosynthetic functions of nitrogen, it affects the quality of cabbage namely moisture percentage and ascorbic acid (Vit. C) Content of cauliflower curd (Toivonen *et al*. 1994) [17].

IAA involves in biosynthetic process of plant and works with enzymes. It has been well recognized that the physiological effects of these substances have strong bearing on flower behaviour of many agricultural crops (Lillo and Hanson, 1987). In recent years, NAA has become increasingly popular to apply NAA as foliar spray (Patil *et al*., 1987; Partha and Mallik, 1989 in cauliflower and Singh *et al*., 1989) [8] in

radish. The ascorbic acid content and yield also increased by application of NAA at 120 ppm (Mishra *et al*., 1984; Patil, 1989; Zee, 1978; Muthoo *et al*., 1987) [8, 18]. Flowering can be induced by application of gibberellic acid in some species. It was found that application of GA (100 ppm) was effected in increasing height of plant, leaf size and curd diameter of cauliflower (Reddy, 1989; Islam, 1985) [11]. It is clear that the hormone proves the synthesis of new enzymes and this is associated with stimulation of RNA synthesis, but there are other effects of the hormone, which appear to be involved in the alterations in the formation of some membranes and membrane components in the cell. (Badawi and Sahhar, 1978; Booij, 1989) [2]. However, GA also affected the quality of cauliflower regarding the colour, compactness and ascorbic acid content of curd (Abdalla *et al*., 1980; Booij, 1990) [1, 3]. The combination effect of nitrogen with NAA significantly affected most of the growth characters at all the stages. The interaction of nitrogen with gibberellic acid was also significantly effective on most of the growth characters at all stages of observation (Mishra and Singh, 1986; Reddy, 1989) [9, 8, 11]. The combination of NAA with GA was also significantly effective on most of the growth, yield and quality characters at all the stages of observation. The interaction of nitrogen, NAA and GA manifested a significant improvement in the size, weight and quality of curd at final stage of observation (Pant and Kedar, 1981). Maximum records for these characters were noted with 2.0% Nitrogen. (Table 2-12). Maximum diameter of the curd (19.35 cm), fresh weight of curd (1432.75g), yield (421 q/ha) and ascorbic acid content (24.68 mg/100g) of curd were recorded at 2.0% nitrogen. However, maximum moisture percentage (93.06%) was recorded at maximum nitrogen (2.0 %) concentration. The various growth character as referred earlier were noted to be maximum at 120 ppm (NA_2) (Table 2-12).

Yield attributing characters and quality characters of curd were also highest at 120 ppm of NAA application. The maximum diameter of curd (18.72 cm), fresh weight (1324.87 g), yield (382.57q/ha) and the ascorbic acid (23.32mg/100 g) of curd were recorded with NA_2 treatment. The 100 ppm GA (G_2) produced maximum effect on the height of plant, length of root, number of outer leaves, total number of leaves per plant, fresh and dry weight of the plant. (Table 2-12). Maximum diameter of curd (18.85 cm), fresh weight (1304.34 g), yield (374.75q/ha) and ascorbic acid content (22.99 mg/100g) of curd were recorded with G_2 (100 ppm) treatment. In two factor combinations, maximum values were obtained under N_2NA_2 treatment in most of the growth attributing character at all the stages of observation, i.e.19.52cm for diameter 0f curd, 1471.50g for fresh weight, 437.16q/ha for yield and 25.69mg/100g for ascorbic acid content of the curd (Singh *et al*., 2015) [16].

In second order interaction, the three factor combination $N_2NA_2G_2$ gave better response as compared to $N_2NA_2G_1$ and control. In these interaction maximum values was often under $N_2NA_2G_2$ combination followed by N_2NAG_1 in most of the growth attributing character of the plants at all stages of observation. Yield, yield attributing characters and quality character were highest, which was recorded under $N_2NA_2G_2$, except in moisture percentage of curd. The maximum values for the diameter of curd (19.88cm), fresh weight (1520.40g), yield (454.41q/ha) and ascorbic acid content (26.22mg/100g) was recorded under $N_2NA_2G_2$. The highest values 93.32% was recorded under $N_2NA_2G_2$ combinations. The profitable cultivation of broccoli crop under the agro climatic condition of Varanasi region, application of nitrogen at 2.0%, NAA at 120ppm and GA_3 at 100ppm are more effective for better growth, development, yield and quality of broccoli.

Table 1: Details of physical and chemical analysis methods.

Physical analysis	Contents	Methods followed
Coarse sand	13.39%	
Fine sand	45.32%	Bouyoucos Hydrometer
Silt	28.12 %	Bouyoucos, 1969
Clay	17.79%	
Chemicals analysis		
Available Nitrogen	0.085%	Modified Kjeldahl
Available Phosphorous	0.078%	Bicarbonate extractable P and development of value kale.
Available Potash	0.031%	Neutral Normal Amm. acetate
pH	7.2	Glass electrode pH metre.

Table 2: Plant Height (cm)

Age in days			0% N_0				1% N_1				2% N_2				Mean	Mean
			NA_0	NA_1	NA_2	Mean	NA_0	NA_1	NA_2	Mean	NA_0	NA_1	NA_2	Mean		
			0ppm	60ppm	120ppm		0ppm	60ppm	120ppm		0ppm	60ppm	120ppm			
30	G_0	0ppm	15.08	15.14	15.20	15.14	17.02	17.28	17.97	17.42	19.45	19.52	20.39	19.78	17.44	$NA_0$17.44
	G_1	50ppm	15.41	15.47	15.53	15.47	17.41	17.57	18.39	17.79	19.69	19.78	20.65	20.04	17.77	$NA_1$17.59
	G_2	100ppm	15.50	15.65	15.73	15.63	17.67	17.93	15.68	18.09	19.80	20.03	21.51	20.44	18.05	NA_2 18.22
	Mean		15.33	15.42	15.48	15.41	17.37	17.59	15.34	17.77	19.64	19.77	20.85	20.08		
60	G_0	0ppm	26.11	26.94	27.05	26.70	28.72	29.74	27.43	29.63	32.71	33.56	35.53	33.94	30.09	$NA_0$29.50
	G_1	50ppm	26.45	27.22	27.82	27.16	28.97	30.13	28.22	30.10	32.98	34.16	36.48	34.54	30.60	$NA_1$30.57
	G_2	100ppm	26.82	27.63	28.24	27.56	29.39	30.82	28.46	30.55	33.36	34.92	36.97	35.08	31.06	NA_2 31.63
	Mean		26.46	27.26	27.70	27.14	29.02	30.23	28.03	30.09	33.01	34.21	36.16	34.46		
90	G_0	0ppm	38.17	38.67	39.96	38.94	40.93	41.27	38.88	41.36	42.45	42.96	43.44	42.95	41.08	NA_0 40.76
	G_1	50ppm	38.45	39.13	40.45	39.34	41.17	41.71	39.13	41.67	42.65	43.19	43.73	43.19	41.40	NA_1 41.30
	G_2	100ppm	38.72	39.47	40.70	39.63	41.50	41.94	39.41	41.95	42.85	43.36	43.94	43.38	41.65	$NA_2$42.07
	Mean		38.44	39.09	40.37	39.30	41.20	41.64	39.14	41.66	42.65	43.17	43.70	43.17		

Treatments	C.D. after days of transplanting					
	30 days		60 days		90 days	
	5%	1%	5%	1%	5%	1%
N;NA;G	0.1005	0.1355	0.0687	0.1434	0.0408	0.0637
N×NA;N×G;NA×G	0.1934	0.4278	0.1993	0.1770	0.0777	0.0981
N×NA×G	0.3502	0.5946	0.2861	0.3653	0.1275	0.1660

Table 3: Total no. of outer leaves

Age in days			0% N_0				1% N_1				2% N_2				Mean	Mean
			NA_0	NA_1	NA_2	Mean	NA_0	NA_1	NA_2	Mean	NA_0	NA_1	NA_2	Mean		
			0ppm	60ppm	120ppm		0ppm	60ppm	120ppm		0ppm	60ppm	120ppm			
30	G_0	0ppm	11.20	12.23	12.65	12.02	12.35	13.12	13.21	12.86	13.12	13.17	14.41	13.57	12.82	NA_0 13.34
	G_1	50ppm	13.34	13.49	13.55	13.46	14.05	13.08	13.90	13.67	13.96	14.23	14.85	14.34	13.82	NA_1 13.61
	G_2	100ppm	13.47	14.11	14.25	13.94	14.08	14.50	14.65	14.41	14.51	14.68	15.24	14.81	14.38	NA_2 14.07
	Mean		12.67	13.27	13.48	13.14	13.49	13.56	13.92	13.65	13.86	14.02	14.83	14.23		
60	G_0	0ppm	18.17	18.46	18.75	18.46	19.10	19.60	19.98	19.56	20.32	20.67	21.25	20.74	19.58	NA_0 19.04
	G_1	50ppm	18.36	18.70	19.07	18.71	19.37	19.86	20.12	19.78	20.52	20.93	21.57	21.00	19.83	NA_1 19.79
	G_2	100ppm	18.60	18.82	19.25	18.89	19.57	19.93	20.27	19.92	20.62	21.12	21.86	21.20	20.00	NA_2 20.23
	Mean		18.37	18.66	19.02	18.68	19.34	19.80	20.12	19.75	20.39	20.90	21.56	20.98		
90	G_0	0ppm	16.26	17.98	17.41	16.88	17.73	17.97	18.11	17.93	18.62	18.70	19.47	18.93	17.91	NA_0 17.67
	G_1	50ppm	16.48	17.12	17.65	17.08	17.81	18.09	18.45	18.11	18.75	19.11	18.59	18.81	18.00	NA_1 18.09
	G_2	100ppm	16.73	17.32	17.85	17.30	17.97	18.28	18.58	18.27	18.76	19.26	19.66	19.22	18.26	NA_2 18.41
	Mean		16.46	17.14	17.63	17.08	17.83	18.11	18.38	18.10	18.71	19.02	19.24	18.99		

Treatments	C.D. after days of transplanting					
	30 days		60 days		90 days	
	5%	1%	5%	1%	5%	1%
N;NA;G	0.8412	0.9170	0.7210	0.9904	0.2595	0.3190
N×NA;N×G;NA×G	0.9177	0.7891	0.7928	0.8031	0.3875	0.5227
N×NA×G	0.8235	0.9910	0.9631	0.8784	0.6986	0.9082

Table 4: Total no. of leaves

Age in days			0% N_0				1% N_1				2% N_2				Mean	Mean
			NA_0	NA_1	NA_2	Mean	NA_0	NA_1	NA_2	Mean	NA_0	NA_1	NA_2	Mean		
			0ppm	60ppm	120ppm		0ppm	60ppm	120ppm		0ppm	60ppm	120ppm			
30	G_0	0ppm	11.20	12.22	12.65	12.02	12.35	13.10	13.20	12.88	13.12	13.17	14.39	13.56	12.82	$NA_0$13.34
	G_1	50ppm	13.34	13.50	13.55	13.46	14.05	13.07	13.89	14.00	13.97	14.22	14.86	14.35	13.93	$NA_1$13.97
	G_2	100ppm	13.48	14.10	14.26	13.94	14.09	14.50	14.65	14.41	14.52	14.67	15.22	14.80	14.38	$NA_2$4.07
	Mean		12.67	13.27	13.48	13.14	13.49	13.89	13.91	13.76	13.87	14.02	14.82	14.23		
60	G_0	0ppm	23.45	23.72	23.77	23.65	23.17	24.80	25.75	24.90	26.25	27.18	28.32	27.25	25.87	$NA_0$24.92
	G_1	50ppm	23.62	23.94	24.09	23.88	24.54	25.25	26.07	25.88	26.64	27.57	28.69	27.63	25.60	$NA_1$25.60
	G_2	100ppm	23.80	24.14	24.46	24.13	24.75	25.65	26.58	25.66	27.12	28.21	29.22	28.18	25.29	$NA_2$26.32
	Mean		23.62	23.93	24.10	23.88	24.49	25.23	26.13	25.28	26.67	27.65	28.74	27.68		
90	G_0	0ppm	40.19	40.64	41.11	40.64	41.39	42.24	43.00	42.21	43.96	44.81	45.30	44.69	42.51	$NA_0$42.21
	G_1	50ppm	40.52	40.85	41.36	40.91	41.87	42.56	43.32	42.58	44.35	44.97	45.45	44.92	42.80	$NA_1$42.81
	G_2	100ppm	40.72	41.17	41.76	41.21	42.22	42.93	43.69	42.94	44.78	45.26	45.75	45.26	43.13	$NA_2$43.41
	Mean		40.47	40.87	41.41	40.92	41.82	42.57	43.33	42.57	44.36	45.01	45.50	44.95		

Treatments	C.D. after days of transplanting					
	30 days		60 days		90 days	
	5%	1%	5%	1%	5%	1%
N;NA;G	0.0541	0.0882	0.0470	0.0619	0.0571	0.0687
N×NA;N×G;NA×G	0.1010	0.1489	0.0714	0.1078	0.0952	0.3413
N×NA×G	0.2023	0.2547	0.1470	0.1894	0.1580	2071

Table 5: Root length (cm)

Age in days			0% N_0				1% N_1				2% N_2				Mean	Mean
			NA_0	NA_1	NA_2	mean	NA_0	NA_1	NA_2	mean	NA_0	NA_1	NA_2	mean		
			0ppm	60ppm	120ppm		0ppm	60ppm	120ppm		0ppm	60ppm	120ppm			
30	G_0	0ppm	10.10	10.40	11.12	10.54	10.22	11.85	12.91	11.66	11.22	13.19	14.54	12.98	11.72	NA_0 10.96
	G_1	50ppm	10.33	10.83	11.36	10.84	10.95	12.08	13.31	12.11	11.76	13.69	14.85	13.43	12.12	NA_1 12.19
	G_2	100ppm	10.52	10.97	11.67	11.05	11.45	12.51	13.71	12.55	12.12	14.21	15.13	13.12	12.47	NA_2 13.17
	Mean		10.32	10.73	11.38	10.81	10.87	12.14	13.31	12.10	11.16	13.70	14.84	13.41		
60	G_0	0ppm	21.02	21.82	22.57	21.58	22.44	23.21	23.92	23.19	23.74	24.65	24.87	24.42	23.13	NA_0 22.84
	G_1	50ppm	21.39	22.43	22.81	22.21	22.98	23.64	24.17	23.60	24.45	24.83	25.12	24.80	23.53	NA_1 23.51
	G_2	100ppm	21.75	22.33	23.07	22.38	23.29	23.81	24.58	23.89	24.53	24.97	25.47	24.99	23.75	NA_2 24.06
	Mean		21.38	19.19	22.81	22.13	22.90	23.55	24.22	23.55	24.24	24.81	25.15	24.74		
90	G_0	0ppm	29.55	29.65	30.32	29.84	30.23	30.74	31.07	30.68	31.07	31.60	30.06	31.57	30.70	NA_0 30.55
	G_1	50ppm	29.70	29.97	30.35	30.00	30.64	30.97	31.38	30.99	31.33	31.84	32.27	31.81	30.93	NA_1 30.88
	G_2	100ppm	29.82	30.12	30.57	30.17	30.89	31.14	31.58	31.20	31.76	31.97	32.43	32.05	31.14	NA_2 31.33
	Mean		29.69	29.91	30.41	30.00	30.58	30.95	31.34	30.95	31.38	31.80	32.25	31.81		

Treatments	C.D. after days of transplanting					
	30 days		60 days		90 days	
	5%	1%	5%	1%	5%	1%
N;NA;G	0.0208	0.0276	0.0691	0.0798	0.0139	0.0184
N×NA;N×G;NA×G	0.0371	0.0461	0.1070	0.1379	0.0832	0.399
N×NA×G	0.6087	0.0788	0.1808	0.2378	0.0502	0.0403

Table 6: Fresh weight of plants (g)

Age in days			0% N_0				1% N_1				2% N_2				Mean	Mean
			NA_0	NA_1	NA_2	Mean	NA_0	NA_1	NA_2	Mean	NA_0	NA_1	NA_2	Mean		
			0ppm	60ppm	120ppm		0ppm	60ppm	120ppm		0ppm	60ppm	120ppm			
30	G_0	0ppm	11.97	12.40	13.72	12.70	14.43	15.39	16.35	15.39	16.98	17.89	19.25	18.04	15.37	NA_0 14.84
	G_1	50ppm	12.11	12.88	14.17	13.05	14.79	15.85	16.77	15.80	17.50	17.64	19.76	18.30	15.71	NA_1 15.64
	G_2	100ppm	12.48	13.24	14.55	13.42	15.37	16.28	17.16	16.27	17.97	19.20	20.69	19.28	16.32	NA_2 16.93
	Mean		12.18	12.84	14.14	13.05	14.86	15.84	16.76	15.82	17.48	18.24	19.90	18.54		
60	G_0	0ppm	99.46	112.12	134.71	115.43	114.59	142.43	155.34	137.45	127.32	133.81	168.56	143.23	132.03	NA126.43
	G_1	50ppm	108.56	120.38	143.57	124.17	123.48	154.47	168.70	148.88	143.75	152.10	193.63	163.16	145.40	NA143.98
	G_2	100ppm	112.72	132.45	150.63	131.94	137.40	166.65	177.49	157.51	170.62	181.47	204.47	185.52	159.32	$NA_2$157.34
	Mean		106.91	121.65	142.97	123.84	125.15	154.51	167.17	148.94	147.23	155.79	161.88	163.97		
90	G_0	0ppm	1223.17	1262.41	1305.64	1263.74	1334.43	1379.32	1423.63	1379.12	1468.11	1504.73	1605.03	1525.95	1389.60	$NA_0$1364.25
	G_1	50ppm	1239.38	1288.54	1338.50	1288.80	1360.36	1417.43	1465.42	1414.40	1492.99	1548.86	1665.29	1569.04	1424.08	$NA_1$1417.10
	G_2	100ppm	1251.55	1299.53	1372.17	1307.75	1388.62	1452.82	1486.83	1442.75	1519.65	1600.33	1712.67	1610.88	1453.79	$NA_2$1486.12
	Mean		1238.04	1283.49	1338.77	1286.76	1361.13	1416.52	1458.62	1412.09	1493.58	1551.30	1660.99	1568.62		

Treatments	C.D. after days of transplanting					
	30 days		60 days		90 days	
	5%	1%	5%	1%	5%	1%
N;NA;G	0.1130	0.0187	0.0729	0.0960	2.5880	2.5870
N×NA;N×G;NA×G	0.1970	0.0245	1.2520	1.6458	2.7570	3.7150
N×NA×G	0.3375	0.4424	2.1680	2.8541	3.7640	6.2627

Table 7: Dry weight of plants (g)

Age in days			0% N_0				1% N_1				2% N_2				MEAN	MEAN
			NA_0	NA_1	NA_2	Mean	NA_0	NA_1	NA_2	Mean	NA_0	NA_1	NA_2	Mean		
			0ppm	60ppm	120ppm		0ppm	60ppm	120ppm		0ppm	60ppm	120ppm			
30	G_0	0ppm	0.68	0.72	081	0.71	0.83	0.85	0.92	0.87	0.92	1.11	1.40	1.13	0.89	NA_0 0.80
	G_1	50ppm	0.71	0.79	0.86	0.76	0.85	0.91	0.98	0.91	0.98	1.26	1.48	1.23	0.95	NA_1 0.95
	G_2	100ppm	0.75	0.83	0.89	0.79	0.78	0.94	1.02	0.91	1.00	1.32	1.50	1.26	0.98	NA_2 1.40
	Mean		0.71	0.78	0.85	0.75	0.82	0.90	0.97	0.90	0.97	1.23	1.46	1.21		
60	G_0	0ppm	11.07	12.01	13.46	9.17	15.50	16.85	18.07	16.80	18.72	19.21	21.92	19.65	16.20	NA_0 15.87
	G_1	50ppm	11.86	13.33	14.72	10.29	16.66	17.61	18.91	17.72	19.25	20.25	19.97	19.69	16.90	NA_1 17.06
	G_2	100ppm	12.49	14.60	15.98	11.34	17.22	18.63	19.68	18.51	20.15	21.00	22.76	21.30	18.05	NA_2 18.22
	Mean		11.10	13.31	14.72	10.27	16.46	17.70	18.88	17.67	19.37	20.18	21.08	20.21		
90	G_0	0ppm	86.28	90.35	100.27	89.49	111.17	119.34	133.66	121.39	152.20	167.90	181.55	167.21	127.03	$NA_0$122.00
	G_1	50ppm	88.53	95.76	107.57	94.27	115.61	123.75	148.50	130.95	161.71	175.57	190.67	175.98	134.73	$NA_1$133.04
	G_2	100ppm	92.20	101.09	113.66	99.30	121.79	134.54	156.37	137.57	168.65	184.11	194.40	182.38	140.75	$NA_2$147.47
	Mean		88.98	95.73	107.37	94.35	116.19	127.54	146.17	129.96	160.85	175.86	188.87	175.19		

Treatments	C.D. after days of transplanting					
	30 days		60 days		90 days	
	5%	1%	5%	1%	5%	1%
N;NA;G	0.0281	0.03894	0.1896	0.2376	0.3788	0.4213
N×NA;N×G;NA×G	0.0532	0.0676	0.3167	0.4113	0.6475	0.8909
N×NA×G	0.0884	0.1187	0.5419	1.5411	1.1214	1.4838

Table 8: Diameter of curd (cm)

Age in days			0% N_0				1% N_1				2% N_2				Mean	Mean
			NA_0	NA_1	NA_2	Mean	NA_0	NA_1	NA_2	Mean	NA_0	NA_1	NA_2	Mean		
			0ppm	60ppm	120ppm		0ppm	60ppm	120ppm		0ppm	60ppm	120ppm			
90	G_0	0ppm	17.09	17.24	17.56	17.29	17.86	18.16	18.48	18.16	18.80	19.11	19.52	19.14	18.20	NA_0 18.08
	G_1	50ppm	17.20	17.42	17.83	17.48	18.06	18.38	18.66	18.37	18.97	19.41	19.72	19.37	18.40	NA_1 18.37
	G_2	100ppm	17.32	17.56	17.98	17.62	18.42	18.55	18.89	18.65	19.21	19.60	19.88	19.56	18.85	NA_2 18.72
	Mean		17.20	17.40	17.79	17.46	18.05	18.36	18.67	18.36	18.99	19.37	19.70	19.35		

Treatments	C.D. after days of transplanting	
	90 days	
	5%	1%
N;NA;G	0.0147	0.0162
N×NA;N×G;NA×G	0.0256	0.0383
N×NA×G	0.0468	0.0579

Table 9: Fresh weight of curd (g)

Age in days			0% N_0				1% N_1				2% N_2				Mean	Mean
			NA_0	NA_1	NA_2	Mean	NA_0	NA_1	NA_2	Mean	NA_0	NA_1	NA_2	Mean		
			0ppm	60ppm	120ppm		0ppm	60ppm	120ppm		0ppm	60ppm	120ppm			
90	G_0	0ppm	1110.42	1132.62	1155.28	1131.77	1180.14	1215.25	1268.61	1221.33	1304.45	1395.40	1471.50	1390.47	1247.85	NA_0 1230.38
	G_1	50ppm	1129.00	1147.49	1172.58	1147.69	1197.19	1242.30	1292.62	1244.03	1395.23	1432.28	1495.28	1740.93	1277.55	NA_1 1274.44
	G_2	100ppm	1138.12	1152.90	1175.71	1160.20	1220.14	1275.30	1362.51	1285.98	1404.79	1475.36	1520.40	1466.85	1304.34	NA_2 1324.94
	Mean		1126.84	1147.67	1171.19	1146.56	1199.15	1244.28	1307.98	1250.45	1368.15	1434.37	1495.72	1432.75		

Treatments	C.D. after days of transplanting	
	90 days	
	5%	1%
N;NA;G	0.0093	0.0116
N×NA;N×G;NA×G	0.1455	0.0197
N×NA×G	0.0261	0.0357

Table 10: Yield of curd (q/ha)

Age in days			0% N_0				1% N_1				2% N_2				Mean	Mean
			NA_0	NA_1	NA_2	Mean	NA_0	NA_1	NA_2	Mean	NA_0	NA_1	NA_2	Mean		
			0ppm	60ppm	120ppm		0ppm	60ppm	120ppm		0ppm	60ppm	120ppm			
90	G_0	0ppm	302.89	310.59	320.10	311.19	328.70	342.05	362.03	344.26	374.30	409.21	437.16	406.89	354.11	NA_0 347.31
	G_1	50ppm	309.07	315.32	325.88	316.75	335.47	350.83	370.82	352.37	408.44	419.85	444.97	424.42	364.51	NA_1 363.50
	G_2	100ppm	312.24	321.34	331.20	321.59	343.15	364.41	396.60	368.05	411.59	437.87	454.41	434.62	374.75	NA_2 382.57
	Mean		308.06	315.75	325.72	316.51	335.72	352.43	376.48	354.89	398.11	422.31	445.51	421.97		

Treatments	C.D. after days of transplanting	
	90 days	
	5%	1%
N;NA;G	0.6698	0.8813
N×NA;N×G;NA×G	1.1672	1.5249
N×NA×G	2.0290	2.6513

Table 11: Moisture percentage (%)

Age in days			0% N_0				1% N_1				2% N_2				mean	Mean
			NA_0	NA_1	NA_2	Mean	NA_0	NA_1	NA_2	Mean	NA_0	NA_1	NA_2	Mean		
			0ppm	60ppm	120ppm		0ppm	60ppm	120ppm		0ppm	60ppm	120ppm			
90	G_0	0ppm	91.07	91.29	91.64	91.33	91.95	92.28	92.42	92.21	92.65	92.95	93.14	92.91	92.15	NA_0 91.89
	G_1	50ppm	91.14	91.35	91.87	91.45	91.84	92.37	92.60	92.27	92.84	93.23	93.69	93.25	92.32	NA_1 91.94
	G_2	100ppm	91.31	91.51	91.77	91.53	92.04	92.31	92.54	92.29	92.72	93.02	93.32	93.02	92.40	NA_2 92.01
	Mean		91.17	91.38	91.76	91.43	91.94	92.32	92.52	92.25	92.70	93.06	93.38	93.06		

Treatments	C.D. after days of transplanting	
	90 days	
	5%	1%
N;NA;G	0.6696	0.8713
N×NA;N×G;NA×G	1.1652	1.5239
N×NA×G	2.0298	2.6515

Table 12: Ascorbic Acid (mg/100gm)

Age in days			0% N_0				1% N_1				2% N_2				Mean	Mean
			NA_0	NA_1	NA_2	Mean	NA_0	NA_1	NA_2	Mean	NA_0	NA_1	NA_2	Mean		
			0ppm	60ppm	120ppm		0ppm	60ppm	120ppm		0ppm	60ppm	120ppm			
90	G_0	0ppm	20.45	20.72	20.77	20.65	21.17	21.80	22.75	21.90	23.25	24.57	25.69	24.25	22.27	NA_0 21.92
	G_1	50ppm	20.62	20.94	21.09	20.88	21.54	22.25	23.04	22.28	23.64	24.57	25.69	24.63	22.60	NA_1 22.60
	G_2	100ppm	20.80	21.14	21.46	21.13	21.75	22.65	23.58	22.66	24.12	25.21	26.22	25.18	22.99	NA_2 23.32
	Mean		20.62	20.93	21.10	20.88	21.49	22.23	23.13	22.28	23.67	24.65	25.74	24.68		

Treatments	C.D. after days of transplanting	
	90 days	
	5%	1%
N;NA;G	0.0641	0.0842
N×NA;N×G;NA×G	0.1110	0.1459
N×NA×G	0.1923	0.2527

References

1. Abdalla IM, Helal RM, Zaki MES. Studies on the effect of some growth regulators on yield and quality of cauliflower. Annuals of Agricultural Science. Mashthor. 1980; 12:199-208.
2. Badawi MA, El-Sahhar KF. Influence of some growth substances on different characters of cabbage. Research Bulletin, Aim Shams University. 2006; 938:24.
3. Booij R. Effect of gibberellic acid on time of maturity and on yield and quality of cauliflower. Netherlands Journal of Agri science. 1990; 38(4):641-651.
4. Booji R. Effect of growth regulators on curd diameter of cauliflower. Scientia Horticulture. 1989; 38(1-2):23-32.
5. Gopal Lal. Effects of nitrogen and spacing in yield and quality of cabbage. Annals of Biology. 1996; 12(2):242-244.
6. Lillo C, Hansen M. Influence of growth temperature of donor plants media composition on embryo yield and plant regeneration. Norwegian Journal of Agricultural Science. 1987; 1(2):105-109.
7. Mangal JL, Pandit ML, Batra BR. Effect of irrigation intensities and nitrogen level on growth and yield of cabbage. Haryana Journal of Hort. Science. 1982; 11(1/2): 92-96.
8. Mishra HP, Singh BP. Studies on the nutrients and growth regular interaction in the cauliflower. Progressive Horticulture. 1986; 18(1/2):77-82.
9. Mishra SG, Gupta AK, Sharma KN. Effect of NAA and Zinc on vitamin C content and yield of cabbage. Progressive Horticulture. 1984; 18(1/2):92-96.
10. Pant KR, Kedar VP. Effects of fertilizer levels and plant growth regulators on growth and yield of cauliflower. College of Agriculture, Nagpur Magazine. 1980; 53:73-75.
11. Reddy SA. Effect of foliar applications of Urea and Gibberellic Acid of cauliflower. Journal of Research, APAU. 1989; 17(1):79-80.
12. Roy HK. Effect of nitrogen on curd size and yield of cauliflower. Vegetable Science. 1981; 8(2):75-78.
13. Sharma SK, Gosal SS, Minocha JL. The effects of NAA, gibberellic acid (GA_3) and kinetin on cauliflower. Indian Journal of Agricultural Sciences. 1997; 67(4):166-167.
14. Singh M, John SA, Rout S, Patra SS. Effect of GA_3 and NAA on growth and quality of quality of garden pea (*Pisum sativum* L.) Cv. Arkel. The Bioscan. 2015; 10(3):381-383.
15. Singh M, Singh RP, Yadav HS. Response of growth regulators and their method of application on yield of Radish. Bhartiya Krishi Anushandhan Patrika. 1989; 4(2):84-88.
16. Singh VK, Shree S, Kumar R, Singh P, Singh RG. Effect of microbial inoculants and inorganic fertilizers on growth and yield of hybrid cabbage (*Brassica oleracea* L. var. capitata). The Bioscan. 2015; 10(3):1227-1231
17. Toivonen PMA, Zebarth BJ, Bowen PA. Effect of nitrogen fertilization on head size, Vitamin C contain and storage life of Broccoli. Canadian Journal of Plant Science. 1994; 74(3):607-610.
18. Zee SY. The effect of Gibberellic Acid (GA_3) on plant growth before and after transplanting. Acta Horticulture. 2000; 72:185-190.