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Effect of plant growth regulators on growth and quality of onion (*Allium cepa* L.)

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Abstract
A field experiment was conducted during two consecutive years 2019-20 and 2020-21 in rabi season at Agriculture Research Farm, Veer Bahadur Singh Purvanchal University, Jaunpur (U.P) to study the effect of plant growth regulators on growth and quality of onion (*Allium cepa* L.). The trial was laid down in randomized block design (RBD) with three replications and ten treatments *viz.* T_1- Control- Distilled Water, T_2. GA3- 50 ppm, T_3. GA3- 100 ppm, T_4. GA3- 150 ppm, T_5- NAA – 50 ppm, T_6- NAA- 100 ppm, T_7- NAA – 150 ppm, T_8- Kinetin- 50 ppm, T_9- Kinetin- 100 ppm, T_{10}- 150 ppm. Study results revealed that, there was significant statistical variation in plant height (cm), Number of leaves per plant, collor width (cm) Fourth leaf length (cm) and fourth leaf width (cm), leaf area index, Chlorophyll value, TSS, and Sulphur content. Maximum plant height (29.60 and 31.10 cm at 30 DAT, 46.90 and 48.10 cm at 60 DAT and 66.20 and 66.90 cm at 90 DAT), Number of leaves per plant (5.00 and 5.20 at 30 DAT and, 8.00 and 7.90 at 60 DAT and 12.00 and 12.30 at 90DAT), Fourth leaf length (22.50 and 22.90 cm at 30 DAT, 42.10 and 43.70 at 60 DAT and 46.50 and 47.50 cm at 90 DAT) and fourth leaf length width (0.47 and 0.47 cm at 30 DAT, 1.20 and 1.22cm at 60 DAT 1.52 and 1.56 90 DAT), collor width (1.15 and 1.15 cm)leaf area index (0.52 and 0.61 at 30 DAT, 3.10 and 3.01 at 60 DAT and 4.66 and 5.31 at 90 DAT), Chlorophyll value(0.52 and 0.61at 30 DAT and 3.01 and 3.01 DAT and 4.66 and 5.31 at 90 DAT, TSS (15.50 and 15.22) in T7, and Sulphur content (0.991 and 0.922).

Keywords: Bolting, GA3, Kinetin, NAA, Sulphur content

Introduction
Onion (*Allium cepa* L.) is one of the most important bulbous vegetable crop, belongs to family *alliaceae* and is said to be native of Central Asia and Mediterranean region Onion is popularly known as “Queen of Kitchen”. Onion is an export oriented crop which is helps in earning valuable foreign exchange for the country. Onions are found in most of the all markets of the world throughout the year and it can be grown under wide range of Agro-climatic conditions of country. Onion crop export is done primarily to Malaysia, Singapore, Philippines, Indonesia, Gulf countries and Pakistan as it is primarily used as seasoning for a wide variety of dishes in kitchen as condiments as well as vegetables, despite its price. Now-a-days white onion is widely used in dehydrated form. (Hanley and Fenwick, 1985) [9]. In addition to being consumed uncooked, onion serves as a very excellent raw material for the food preparation industries and it can be manufactured into rings, shreds, powder, or onion in vinegar or brine. In India particularly in Maharashtra and Gujarat, the crop has gained importance of cash crop rather than a vegetable crop because of its very high export potential. Onion contains many bioactive compounds and its nutritive value 100 g of edible portion is moisture (86.8%), Carbohydrates (11.0 g), protein (1.2 g), fiber (0.6 g), mineral (0.4 g), thiamine (0.08 mg), vitamin (11 mg), calcium (180 mg), phosphorus (50 mg), iron (0.7 mg), nicotinic acid (0.4 mg) and riboflavin (0.01 mg) (Mishra, 1963) [11]. Onion is characterized by their rich content of odoriferous sulfur compounds such as thiosulfinates, sulfides and sulfoxides etc. The eye-irritating chemicals that cause lacrimation and the compound thiosulfinates of cysteine sulfoxides, which create the onion taste and it have antimicrobial qualities. The pungency in onion is caused by a volatile substance known as allyl propyl disulphide, which is useful against many disease causing pathogens such as *Bacillus subtilis*, *Salmonella* sp., and *E. coli*. Onion is well known for its medicinal properties and it plays an important role in preventing heart diseases and other ailments.

The medicinal reports have shown that onion can lower blood lipids and prevents the hardening of arteries, cancer, liver and intestinal problems. Besides, onion flavonoids have anti-diabetic, anti-aging, and bacterial inhibition effects. It is said to possess stimulant, diuretic, expectorant properties and is considered useful in flatulence, fevers, heart and dysentery. Onion is a vital rejuvenator and revitalizer (Rai and Yadav, 2005 and Augusti, 1990) [11, 1].

In India major onion producing states are Maharashtra, Karnataka, Uttar Pradesh, Gujarat production, Madhya Pradesh and Bihar. The growth and yield of crops are mainly influenced by genetical and cultural factors. The first factor deals with the various plant breeding techniques used for the improvement of crop varieties. The second factor deals with supply of adequate nutrition, growth substances and plant protection etc. Both these factors have been fully exploited by various research workers in respective field with varied success. The productivity of onion is low as compare to other countries. Beside use of improved varieties, nutrition and irrigation factors play a significant role in increasing productivity. Application of plant growth regulators (PGRs) is one of the easy and sustainable way to enhance onion production and productivity. Now a days, plant growth regulators are playing very important role in increasing the growth and yield of onion crops, if applied in proper concentration and at proper time (Singh *et al.* 1983) [12]. Mondal, (2005) [10] reported that yield of onion can be increased through different PGRs. The growth regulators are considered as a key factor in controlling the vegetative growth, flowering and seed production in plants. Now a days, plant growth regulators speed up production time as well as production of high quality and market friendly products by farmers and manufacturers of agricultural products.

Growth regulators are organic compounds other than nutrients produced in small amount and modifying or regulate growth and development. Such organic compounds occurring naturally in plants as well as synthetic other than nutrients which in small amount promote, inhibit or modify any physiological process are called plant growth regulators. The term phytohormone is derived for hormone of plants. Among the growth regulators auxin causes enlargement of plant cell and gibberellins stimulate cell division, cell enlargement or both.

Plant growth regulators are known to regulate and modify various physiological processes in plant and they exhibit their effect on morphological characters and yield. The production and distribution of photosynthates is related to various physiological and biological processes, which are influenced by the plant growth regulators. Plant growth regulators are effectively utilize in vegetable crops for improving seed germination, breaking dormancy, flower induction, increasing fruit setting and yield, fruit ripening, sex expression, hybrid seed production, gametocidal action and in male sterility (Bajracharya *et al.*, 1979; Kalloo, 1974) [4, 7]. Number of techniques are used for application of plant growth substances have been investigated on various vegetables crops. The methods adopted successfully are seed treatment, seedling treatment and foliar application for higher production, whereas post-harvest treatment for increasing shelf-life in various vegetables. Different growth regulators like auxins, gibberellins have been used in onion. Although the naturally occurring (endogenous) growth substances normally control plant growth, modification of growth can be produced by application of exogenous growth substances, some of which may produce beneficial effects (Weaver, 1972) [13]. Today various plant growth promoters, inhibitors and retardants are available in the market in synthetic forms and they act as mimic as natural hormones. Among the different plant growth regulators, gibberellins fall in growth promoter group. In gibberellins, GA3 is the most important growth regulator for cell elongation and cell enlargement. Gibberellin is beneficial for increase in shoot elongation in many plant species that is especially marked when certain dwarf mutants are treated. Gibberellic acid is an important growth regulator that can be used in a variety of ways to modify plant development, production, and yield-contributing traits. When applied as a foliar spray, gibberellic acid improves the bulb yields in onion. (Asgharzadeh, 2014) [2]. Gibberellins promote shoot growth by accelerating the cell elongation and cell division in sub apical meristem region. It regulates the mitotic activity of sub apical meristem and it increases the size of leaves, breaking dormancy and prevent senescence. GA_3 inhibits senescence mainly by modulation of lipid peroxidation through maintaining high levels of such cellular scavengers as SOD and catalase (Dhindsa *et al.*, 1982) [5].

The primary physiological effect of auxins on growth of a plant is the elongation of cells. The cell elongation is activated by auxin in three ways, by increasing osmotic solutes, by decreasing wall pressure and by increasing permeability of cytoplasm to water (Katyayan, 2001) [8]. Naphthalene Acetic Acid (NAA) belongs to synthetic forms of auxins. It play key role in cell elongation, cell division, vascular tissue differentiation, root initiation, apical dominance, leaf senescence, leaf and fruit abscission, fruit setting and flowering (). NAA had a significant effect on plant height, number of leaves, bulb diameter, bulb weight, bulb yield and total soluble solids of onion (Bista *et al*. 2022) [3].

Gibberellic acid, NAA and its combination treatments as pre-harvest foliar application has gained prominence effect in various physiological activities of plants. Application of GA3 and NAA in combination at different leaf stages stimulates morphological characters like plant height, number of leaves, bulb diameter, neck thickness, bulb weight and bulb yield. Therefore it is necessary to find out the effective doses of GA3 and NAA in promoting growth and yield components and quality of onion.

Nephthalene acetic acid (NAA) cause cell elongation, resulting in curvature of stems, epinasty of leaves, proliferations involving cell division and emergence of adventitious roots, inhibition of buds and regulation of growth (Thimann and Went, 1934). Application of NAA, in different concentration the highest bulb length, bulb diameter, bulb weight plant per plant and bulb yield per hectare was recorded by the application of NAA at the rate 100 ppm (Gupta *et al.*, 2022) [6].

Materials and Methods

A field experiment was conducted during two consecutive rabi season of 2019-20 and 2020-21 Agriculture Research Farm, Veer Bahadur Singh Purvanchal University, Jaunpur (U.P). The trial was laid down in randomized block design (RBD) with three replications and ten treatments *viz*. T_1- Control- Distilled Water, T_2. GA3- 50 ppm, T_3. GA3- 100 ppm, T_4. GA3- 150 ppm, T_5- NAA – 50 ppm, T_6- NAA- 100 ppm, T_7- NAA – 150 ppm, T_8- Kinetin- 50 ppm, T_9- Kinetin- 100 ppm, T_{10}- 150 ppm. Study results revealed that, there was significant statistical variation in plant height (cm), Number of leaves per plant, collor width (cm) Fourth leaf length (cm) and fourth leaf width (cm), leaf area index, Chlorophyll value, TSS, Bolting % and Sulphur content. The crop was raised at spacing of 20 cm x 10 cm and plot size of 1x1m. Standard culture practices recommended for onion was followed uniformly in all experimental plots.

Table 1: Details of treatments

Treatment	Doses
T1 =Control	Distilled water
T2= GA3	50 ppm
T3 = GA3	100 ppm
T4= GA3	150 ppm
T5 =NAA	50 ppm
T6= NAA	100 ppm
T7= NAA	150 ppm
T8= Kinetin	50 ppm
T9= Kinetin	100 ppm
T10 = Kinetin	150 ppm

Observation recorded

1. **Plant height (cm):** Five plants were randomly selected from each plot, tagged permanently and used for measurement of the plant height with the help of meter scale and then average plant height was calculated.
2. **Number of leaves per plant:** Number of leaves in selected plants were counted at the time of harvesting and then averaged.
3. **Fourth Leaf length (cm):** Leaf length of selected plants was measured with the help of centimetre scale and the average number of leaves per plant was worked out.
4. **Fourth Leaf width (cm):** Leaf width of selected plant was measured with the help of centimetre scale and average leaf width was calculated.
5. **Total soluble solids (T.S.S.):** A hand refractometer was used to estimate the total soluble solids in bulbs that were selected at random from each plot.

Chlorophyll value (spad unit)

Chlorophyll valve was measured as SPAD unit with the help of electronic chlorophyll meter. The chlorophyll content was measured in between 9:30-10:30 a.m. in clear sky day at 90 and 120 days after transplanting.

6. **Collar width (cm):** The color width of fully matured bulb from five plants of each treatment was taken by using vernier calipers.

Biometrical Analysis

Experimental data was subjected to biometrical analysis as per the standard as procedure given by Gomez and Gomez (1984) [6].

Table 2: Effect of plant growth regulators on Plant Heigh (cm) and Number of leaves

Treatment	Plant Height s									Number of leaves								
	At 30DAT			60DAT			90DAT			30 DAT			60DAT			90DAT		
	I year	II year	Pooled	I year	II year	Pooled	I year	II year	Pooled	I year	II year	Pooled	I year	II year	Pooled	I year	II year	Pooled
T1	22.05	21.20	21.63	37.50	35.60	36.55	51.10	50.20	50.65	2.50	2.20	2.35	5.50	5.10	5.30	9.50	10.10	9.80
T2	26.90	26.80	26.85	43.50	44.60	44.05	63.10	65.20	64.15	4.50	4.80	4.65	7.00	6.50	6.75	11.00	11.50	11.25
T3	28.40	29.70	29.05	45.80	47.40	46.60	66.40	67.10	66.75	5.00	5.40	5.20	7.50	7.80	7.65	12.00	12.10	12.05
T4	32.40	32.60	32.50	48.60	50.80	49.70	69.10	69.00	69.05	6.00	6.30	6.15	8.50	8.60	8.55	12.50	13.80	13.15
T5	26.50	28.40	27.45	44.50	46.50	45.50	63.50	66.10	64.80	4.00	5.10	4.55	6.50	7.60	7.05	10.50	11.40	10.95
T6	30.30	31.30	30.80	47.20	49.20	48.20	67.50	68.10	67.80	5.50	6.00	5.75	7.50	8.20	7.85	11.50	12.90	12.20
T7	33.90	34.20	34.05	50.20	52.10	51.15	70.60	69.20	69.90	6.50	6.70	6.60	9.00	8.90	8.95	13.00	14.20	13.60
T8	25.60	27.60	26.60	41.40	43.60	42.50	61.20	63.50	62.35	4.00	4.20	4.10	6.50	6.90	6.70	10.00	10.20	10.10
T9	28.40	28.20	28.30	43.60	46.50	45.05	64.20	65.70	64.95	4.50	4.70	4.60	7.00	7.40	7.20	11.50	11.80	11.65
T10	29.60	31.02	30.31	46.90	48.10	47.50	66.20	66.90	66.55	5.00	5.20	5.10	8.00	7.90	7.95	12.00	12.30	12.15
CV%	2.556	2.391		2.321	2.971		3.017	1.805		2.508	2.506		1.393	2.56		2.946	2.041	
CD%	0.965	0.916		1.630	2.161		2.313	1.415		0.206	0.219		0.176	0.331		0.578	0.424	

Table 3: Effect of plant growth regulators on Fourth Leaf Length, Fourth Leaf Width (cm) and Collor Width (cm)

Treatment	Fourth Leaf Length									Fourth Leaf Width									Collar Width		
	At 30DAT			60DAT			90DAT			30DAT			60DAT			90DAT					
	I year	II year	Pooled	I year	II year	Pooled	I year	II year	Pooled	I year	II year	Pooled	I year	II year	Pooled	I year	II year	Pooled	I year	II year	Pooled
T1	19.50	19.80	19.65	37.20	38.28	37.74	41.28	42.40	41.84	0.40	0.41	0.41	1.10	1.14	1.12	1.34	1.36	1.35	1.11	1.11	1.11
T2	21.40	21.90	21.65	40.20	41.20	40.70	43.20	43.90	43.55	0.44	0.45	0.45	1.15	1.17	1.16	1.47	1.49	1.48	1.13	1.14	1.14
T3	22.20	22.40	22.30	41.00	41.90	41.45	43.90	44.50	44.20	0.46	0.46	0.46	1.19	1.20	1.20	1.48	1.50	1.49	1.15	1.16	1.16
T4	23.00	23.20	23.10	42.50	44.50	43.50	47.80	48.30	48.05	0.49	0.50	0.50	1.25	1.27	1.26	1.67	1.69	1.68	1.20	1.20	1.20
T5	21.00	21.30	21.15	39.00	40.70	39.85	42.60	43.50	43.05	0.43	0.43	0.43	1.13	1.14	1.14	1.44	1.47	1.46	1.13	1.13	1.13
T6	22.70	22.90	22.80	42.00	44.00	43.00	46.00	47.60	46.80	0.47	0.48	0.48	1.25	1.26	1.25	1.56	1.59	1.58	1.18	1.19	1.19
T7	23.40	23.80	23.60	43.00	45.00	44.00	48.50	49.40	48.95	0.51	0.52	0.52	1.30	1.33	1.32	1.70	1.72	1.71	1.24	1.23	1.24
T8	20.60	20.90	20.75	38.40	39.90	39.15	40.90	42.60	41.75	0.41	0.41	0.41	1.11	1.18	1.15	1.38	1.40	1.39	1.12	1.12	1.12
T9	22.12	22.42	22.27	40.70	41.50	41.10	42.80	43.68	43.24	0.45	0.46	0.46	1.18	1.20	1.19	1.40	1.44	1.42	1.15	1.15	1.15
T10	22.50	22.90	22.70	42.10	43.70	42.90	46.50	47.45	46.98	0.47	0.47	0.47	1.20	1.22	1.21	1.52	1.56	1.54	1.17	1.18	1.18
CV%	2.556	2.391		2.321	2.971		3.017	1.805		1.57	3.188		3.462	2.21		2.862	2.313				
CD%	0.965	0.916		1.630	2.161		2.313	1.415		0.012	0.025		0.071	0.046		0.074	0.061				

Table 4: Effect of plant growth regulators on Leaf area Index, Chlorophyll content (mg/ 100gm), Sulpher (mg/100gm) and TSS (ºBrix)

Treatments	Leaf Area Index									Chlorophyll			Sulfer			TSS		
	I year	II year	Pooled	I year	II year	Pooled	I year	II year	Pooled	I year	II year	Pooled	I year	II year	Pooled	I year	II year	Pooled
T1	0.15	0.10	0.13	1.15	1.15	1.15	1.85	2.01	1.93	26.00	26.50	26.25	0.080	0.081	0.081	11.00	10.80	10.90
T2	0.34	0.46	0.40	2.01	2.01	2.01	3.24	3.60	3.42	27.80	28.40	28.10	0.088	0.083	0.084	12.22	11.82	12.02
T3	0.48	0.58	0.53	2.67	2.67	2.67	4.37	4.73	4.55	29.60	30.40	30.00	0.099	0.089	0.094	13.26	13.26	13.26
T4	0.65	0.71	0.68	3.36	3.36	3.36	5.26	5.88	5.57	33.30	34.00	33.65	0.106	0.102	0.104	14.82	14.90	14.86
T5	0.41	0.51	0.46	2.66	2.66	2.66	3.58	4.59	4.09	27.00	27.90	27.45	0.991	0.922	0.956	13.24	12.14	12.69
T6	0.59	0.65	0.62	3.11	3.11	3.11	4.95	5.47	5.21	32.00	32.80	32.40	0.089	0.084	0.0865	14.56	14.62	14.59
T7	0.71	0.75	0.73	3.71	3.71	3.71	5.95	6.20	6.08	34.60	35.60	35.10	0.111	0.114	0.112	15.50	15.22	15.36
T8	0.36	0.41	0.39	2.35	2.35	2.35	3.02	3.57	3.30	26.60	27.36	26.98	0.102	0.920	0.511	12.02	11.32	11.67
T9	0.49	0.53	0.51	2.86	2.86	2.86	4.12	4.94	4.53	28.40	29.00	28.70	0.988	0.902	0.945	13.58	12.74	13.16
T10	0.52	0.61	0.57	3.01	3.01	3.01	4.66	5.31	4.99	30.70	31.27	30.99	0.102	0.970	0.536	14.22	14.11	14.17
CV%	2.751	1.883		3.24	3.24		2.567	4.026		0.952	1.58		3.112	2.765		2.832	2.185	
CD%	0.022	0.017		0.151	0.151		0.182	0.322		1.86	3.014		0.754	0.543		0.658	0.495	

Results and Discussion

Effect of plant growth regulators on growth parameters

The different plant growth regulators and their levels on plant height did differ significantly at 30, 60 and 90 DAP on pooled analysis. Whereas, maximum plant height (34.05, 51.15 and 69.90 cm) was recorded under T7 (NAA 150 ppm) followed by (32.50, 49.70 and 69.05 cm) and (30.80, 48.50 and 67.80 cm) T4 (GA3 150 ppm) and T6 (NAA 100 ppm) respectively. The results showed that T_7 (NAA 150 ppm) and (GA3 150 ppm) was found effective for increasing the plant height of onion.

Among different levels of plant growth regulators, the maximum number of leaves per plant (13.60) was obtained under NAA 150 ppm in pooled data at 90 DATP, followed by (13.15) in GA3 150 ppm.

Among different levels of plant growth regulators, the maximum leaf length (48.95cm) was obtained under NAA 150 ppm in pooled data at 90 DATP, followed by (48.05 cm) GA3 150 ppm.

The collar width of bulb was affected by various concentrations of plant growth regulators. The maximum collar width (1.24 cm) was obtained under NAA 150 ppm in pooled data at 90 DATP, followed by (1.20 cm) GA3 150 ppm.

Similarly, the plant growth regulators and their levels showed a significant effect on the leaf area index at 30, 60 and 90 DATP on a pooled basis among different levels of plant growth regulators, the maximum leaf width (1.71 cm) was obtained under NAA 150 ppm in pooled data at 90 DATP, followed by (1.68cm) GA3 150 ppm.

The chlorophyll value of bulb was affected by various concentrations of plant growth regulators. The maximum chlorophyll value (35.10) was obtained under NAA 150 ppm in pooled data at 90 DATP, followed by (33.65) GA_3 150 ppm.

Effect of plant growth regulators on quality parameters

The quality parameters like total soluble solids and Sulphur content of onion bulbs did differ significantly with plant growth regulators and their various concentrations. That T_7 produced maximum Total soluble solids of onion in pooled data.

Total soluble solids i.e., 15.36 brix was recorded in T7, followed with T_4 and T_6 (14.86 and 14.59 brix) respectively. The lowest onion Total soluble solids were recorded with T_1 (10.90) during in pooled data.

Sulphur content was maximum sulphur content i.e., 0.112 mg/100 gm was recorded with T_7 and it was followed with T_4 and T_9(0.104 and 0.945mg/100 gm) respectively. However, the lowest onion Total soluble solids were recorded with T_1 (0.080, 0.081 mg/100 gm) during I year and II year, respectively.

Conclusion

On the basis of the results, it could be concluded that, the foliar application of NAA 150 ppm and GA3 150 ppm for the onion crop found to be superior treatment, where it recorded significant maximum plant height number of leaves Collor width, Fouth leaf length fourth leaf width Chlorophyll content neck thickness total soluble solids and sulfur content.

In glow of the results obtained from two years investigation, it may be inferred that for securing maximum bulb yield. it is advisable to use NAA150 ppm in onion crop under Jaunpur agro-climatic conditions.

References

1. Augusti KT. Therapeutic and medicinal values of onion and garlic, In: Onions and Allied crops, Vol. III, Boca Raton, Florida, CRC Press; c1990. p. 93-108.
2. Asgharzadeh A. Gibberellic Acid and Stem Length Uniformity, Flowering Time, and Seed Yield Increase in Azarshahr Onions. Indian J of Fundamental and Applied Life Sciences. 2014;4(4):2917-2920.
3. Bista D, Sapkota D, Paudel H, Adhikari G. Effect of foliar application of growth regulators on growth and yield of onion (*Allium cepa*). International Journal of Horticultural Science and Technology. 2022;9(2):247-254.
4. Bajracharya PB, Brar JS, Saimbhi MS. Chemical induction in male sterility in onion (*Allium cepa* L.) Punjab Agric. Univ. J Res. 1979;15(1):276-281.
5. Dhindsa RS, Plumb-Dhindsa PL, Reid DM. Leaf senescence and lipid peroxidation: Effects of some phytohormones, and scavengers of free radicals and singlet oxygen. Physiologia Plantarum. 1982;56(4):453-457.
6. Gomez KA, Gomez AA. Statistical Procedure for Agriculture Research. 2nd Edition, John Wiley and Sons, New York; c1984. p. 680.
7. Gupta M, Rahman T, Ahmed Z, Kabir MH. Effect of nitrogen and naphthalene acetic acid on the growth and yield of summer onion. GSC Advanced Research and Reviews. 2022;10(1):166-176.
8. Kalloo G. Induction of monoecism and its utilization in hybrid seed production by regulating seed mechanism in *Muskmelon* L. Use of certain chemical mutagens and

growth regulators. Punjab Hort. J. 1974;14:56-60.
9. Katyayan A. Fundamentals of agriculture. Kushal Publication and Distributors, Varanasi. 2001;2(1):170-181.
10. Hanley AB, Fenwick GR. Cultivated alliums. Journal of Plant Foods. 1985;6(4):211-238.
11. Mishra R, Ajay T, Junaid Z. Effect of nitrogen and naphthalene acetic acid on the growth and yield of summer onion. International Journal of Horticultural Science and Technology. 1963;11(1):166-176.
12. Mondal S, Shukla N. Effect of GA_3 and NAA on yield and yield attributes of onion cv. N-53. Agric. Sci. Digest. 2005;25(4):260-262.
13. Rai N, Yadav DS. Bulb Vegetables. Advances in Vegetable Prouction, Researchco Book Centre New Delhi; c2005. p. 237-261.
14. Singh AR, Pankaj SL, Singh GN. Effect of growth regulators on the growth, yield and quality of onion. Punjab Hort. J. 1983;23(1-2):100-104.
15. Uddin S, Tiwari J. Response of GA_3 and NAA on yield and yield attributes of onion cv. Pusa red. Agric. Sci. Digest. 2019;22(4):133-142.
16. Weaver RJ. Plant Growth Substances in Agriculture. W. H. Freeman and Co., San Francisco; c1972.