EFFECT OF FOLIAR APPLICATION OF GROWTH REGULATORS ON GROWTH AND YIELD OF ONION (*Allium cepa*).

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ABSTRACT

A field experiment was conducted at Horticulture Farm of Agriculture and Forestry University, Rampur, Chitwan, Nepal from December 1 to April 30 of 2018/19 to evaluate the effect of plant growth regulators on onion (Allium cepa L.). The experiment was laid out in a Randomized Complete Block Design (RCBD) with 13 treatments. Growth regulators GA3 and NAA each at 75, 150 and 200 mg/L concentrations and in combinations were tried at 3 and 7 leaf stages of onion crop in comparison to control i.e. water spray and each was replicated three times. The combined application of NAA 150 mg/L at 3 leaf stage, and GA3 mg/L at 7 leaf stage resulted in highest values for plant height (76.67 cm), number of leaves (11.33), stem diameter (2.19 cm), bulb diameter (7.55 cm), dry weight (69.83 gm) and fresh weight (72.66 gm) while the control treatment resulted in the lowest value for all these attributes. Therefore, the combined application of 150 mg/L of NAA at 3 -leaf stage and 150 mg/L of GA3 at 7-leaf stage can be recommended to enhance the plant growth and yield of onion.

Keywords:
Gibberellic acid (GA3), Naphthalene acetic acid (NAA), Plant Growth Regulators

INTRODUCTION

- Onion (*Allium cepa* L.), an important vegetable crop in Nepal, stands at the third position in production among the vegetable crops in the world after tomato and cabbage (Acharya and Shrestha, 2018).
- Nepal has a per capita consumption of fresh onion of 7.7 kg, which is lower than the global average of 10.8 kg (MYRepublica, 2020). Koirala et al. (1995) reported the production of onion in Nepal is less than half of its annual demand, prompting the county to import 178,500 tonnes of onion worth Rs. 5.62 billion in the fiscal year 2018/19.
- Nepal has already imported 8,010 tonnes of onion worth Rs. 2,950,000 in the first month of this fiscal year 2020/21 (The Rising Nepal, 2020).
- The PGRs are organic compounds that, in small amounts, can modify the growth (Chaurasiya et al., 2014).
- These compounds naturally occur in plants but, when applied externally in small quantities, promote, inhibit or modify any physiological process.
- Rashid (2010) reported the potential of using different PGRs in improving the yield of onions. Safdari et al. (2014) suggested that growth regulators control the vegetative growth, flowering, fruiting, and seed production in plants, increasing production rate and quality as well as market-friendly products.

RATIONALE

- Onion productivity in Nepal is low in comparison to other countries. Among the various interventions, using plant growth regulators (PGRs) are one of the easiest and cheapest methods to enhance productivity.
- Gibberellin, with a gibbane skeleton, is an important growth regulator that modifies growth, yield, and yield contributing characteristics of plants (Rafeekher et al., 2002). Asgharzadeh (2014) reported that the foliar spray of gibberellic acid increases the size of marketable bulbs.
- Although PGRs have the potential to increase the quality, yield, and yield components of onion, the effect of these PGRs has not been researched in the Nepalese context.

OBJECTIVES

This research investigates the effect of different plant growth regulators on the growth and yield onions, which can significantly help to increase the national yield of the onion.

MATERIALS AND METHODS

EXPERIMENTAL DETAILS

A field experiment was conducted at the Olericulture farm of the Horticulture Department, Agriculture and Forestry University, Rampur, Chitwan, Nepal (27°40′ N, 84°30′ E, and 200 m.a.s.l), from November 1, 2018, to April 20, 2019.

PLANT MATERIAL

The seeds of Nasik-53 were bought from local agro-vets. These seeds were treated with fungicide 63% Mancozeb+ 12% Carbendazim W.P. (commercially known as SAFF) before planting.

EXPERIMENTAL DESIGN

The experiment was laid out in a randomized complete block design with three replications. The experiment consisted of thirteen treatments, which is described as follow:

Treatment Number	Treatment Details
T1	Control (water spray)
T2	NAA 75 mg/L at 3 leaf stage and at 7 leaf stage.
T3	NAA 150 mg/L at 3 leaf stage and at 7 leaf stage.
T4	NAA 200 mg/L at 3 leaf stage and at 7 leaf stage.
T5	GA3 75 mg/L at 3 leaf stage and at 7 leaf stage.
T6	GA3 150 mg/L at 3 leaf stage and at 7 leaf stage.
T7	GA3 200 mg/L at 3 leaf stage and at 7 leaf stage.
T8	GA3 75 mg/L at 3 leaf stage + NAA 75 mg/L at 7 leaf stage
T9	GA3 150 mg/L at 3 leaf stage + NAA 150 mg/L at 7 leaf stage
T10	GA3 200 mg/L at 3 leaf stage + NAA 200 mg/L at 7 leaf stage
T11	NAA 75 mg/L at 3 leaf stage + GA3 75 mg/L at 7 leaf stage
T12	NAA 150 mg/L at 3 leaf stage + GA3 150 mg/L at 7 leaf stage
T13	NAA 200 mg/L at 3 leaf stage + GA3 200 mg/L at 7 leaf stage

The treatment was done twice, first at 3 leaf stage and second at 7 leaf stage. There were a total of 39 individual plots of 0.54 m^2, 15 cm between rows, and 10 cm between two individual plants, making almost 70 m^2. Each plot consisted of 49 plants, out of which 10 were taken as sample plants randomly, with a total population of 1911 plants in the overall experimental plot.

MEASUREMENT OF DATA

Height of plant and leaves per plant was recorded to observe growth. In addition, to measure yield and yield contributing characteristics, stem diameter, bulb diameter, the weight of the fresh bulb, weight of the dry bulb, total yield per plot, and total yield per hectare were collected.

STATISTICAL ANALYSIS

The collected data were processed using MS Excel, and the analysis of variance (ANOVA) was performed using R-studio. Multiple comparisons among the means were tested using Duncan's Multiple Range Test (DMRT) at a 5% level of significance (Gomez and Gomez, 1984).

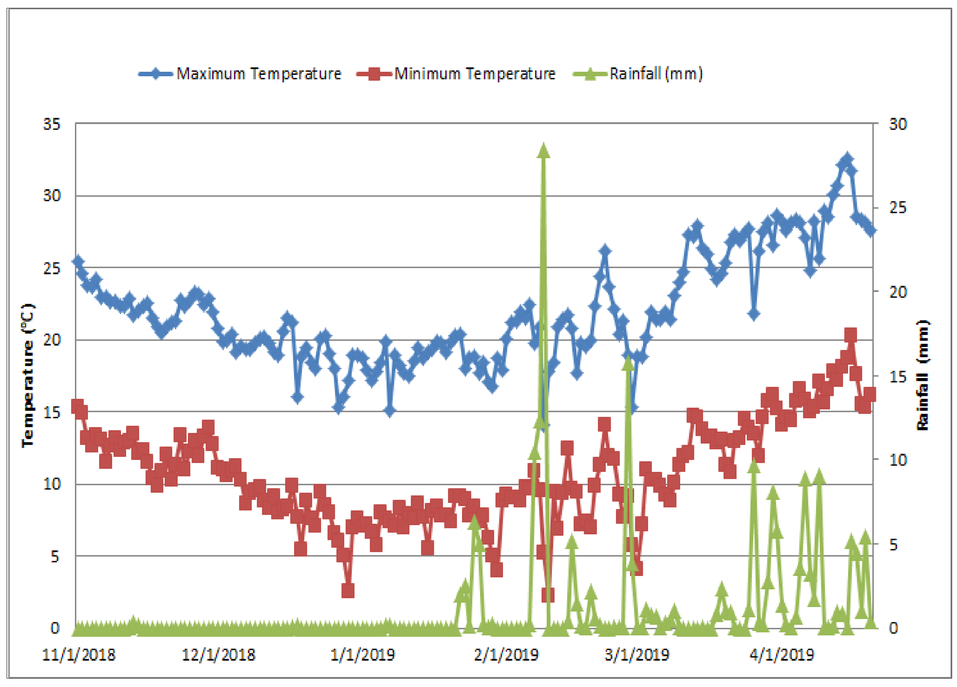

Figure 1. Weather data of experimental location during the growing season of onion in 2018/19 at Rampur, Chitwan, Nepal (NASA power, n.d.)

RESULTS

GROWTH OBSERVATIONS

HEIGHT OF PLANT

Table 1. Effect of foliar application of plant growth regulators on the height of onion (*Allium cepa*.) in Rampur, Chitwan, Nepal, in 2018/2019.

Treatments	Height of Plant (cm)	
	Days after transplanting	
	60***	90**
T1	45.00f	53.53f
T2	59.60d	62.27cd
T5	52.67e	60.53de
T3	68.33ab	69.00b
T4	57.27d	59.80de
T6	56.73d	61.07de
T7	52.67e	61.60cde
T8	66.27bc	66.80b
T9	63.47c	63.87c
T10	56.57d	59.17e
T11	57.20d	60.00de
T12	**71.47a**	**76.67a**
T13	49.13e	61.53cde
SEM (±)	2.59	1.24
LSD (0.05)	3.57	2.47
C.V. %	3.64	2.34
F-value	38.76	43.32
Mean	58.18	62.75

Note: Means followed by a common letter superscript within a column are non-significantly different, whereas the means followed by different letter superscripts within a column are significantly different based on Duncan's Multiple Range Test (DMRT) at P=0.05; NS: Non-Significant; SEM: Standard Error of Mean; CV: Coefficient of Variation; *,** and *** are significant at P=0.05, P=0.01 and P<0.001, respectively.

LEAVES PER PLANT

Table 2. Effect of foliar application of plant growth regulators on the number of leaves of onion (*Allium cepa*.) in Rampur, Chitwan, Nepal, in 2018/2019.

Treatments	Leaves per Plant	
	Days after transplanting	
	60***	90**
T1	6.30d	9.00d
T2	7.90ab	10.53abc
T3	8.07ab	11.07ab
T4	7.57b	10.53abc
T5	6.80c	10.00bcd
T6	7.07c	10.67abc
T7	7.67b	10.87ab
T8	7.87ab	10.90ab
T9	7.90ab	10.40abc
T10	7.87ab	10.60abc
T11	8.00ab	10.81ab
T12	**8.27a**	**11.33a**
T13	6.87c	9.67cd
SEM (±)	0.04	0.16
LSD (0.05)	0.81	0.89
C.V. %	3.52	5.07
F-value	15.03	4.11
Mean	7.54	10.49

Note: Means followed by a common letter superscript within a column are non-significantly different, whereas the means followed by different letter superscripts within a column are significantly different based on Duncan's Multiple Range Test (DMRT) at P=0.05; NS: Non-Significant; SEM: Standard Error of Mean; CV: Coefficient of Variation; *,** and *** are significant at P=0.05, P=0.02 and P<0.001, respectively.

YIELD AND YIELD CONTRIBUTING OBSERVATIONS

Table 3. Effect of foliar application of plant growth regulators on the yield and yield contributing attributes of onion (*Allium cepa*.) in Rampur, Chitwan, Nepal, in 2018/2019.

Treatments	Stem diameter (cm)***	Bulb Diameter (cm)***	Dry weight (gm)***	Fresh weight (gm)**
T1	0.96^{g}	3.93^{e}	38.66^{e}	38.86^{d}
T2	1.53^{b}	4.89^{bcde}	52.33^{bc}	57.10^{abcd}
T3	1.51^{bc}	**7.32^{a}**	60.66^{b}	60.53^{abc}
T4	1.18^{efg}	4.31^{cde}	45.20^{de}	58.53^{abcd}
T5	1.06^{fg}	5.18^{bc}	50.73^{cd}	42.20^{cd}
T6	1.27^{ef}	5.41^{b}	52.20^{cd}	49.40^{bcd}
T7	1.23^{cdef}	5.25^{bc}	54.06^{bc}	52.40^{abcd}
T8	1.55^{b}	4.06^{de}	61.10^{b}	69.86^{ab}
T9	1.50^{bcd}	4.93^{bcd}	56.06^{bc}	**70.93^{a}**
T10	1.18^{efg}	5.00^{bcd}	54.80^{bc}	66.26^{ab}
T11	$1.26d^{ef}$	5.48^{b}	55.33^{bc}	63.73^{ab}
T12	**$.2.13^{a}$**	**7.55^{a}**	**69.83^{a}**	**72.66^{a}**
T13	1.36^{b}	4.70^{bcde}	51.08^{cd}	53.73^{abcd}
SEM (±)	0.009	0.15	9.64	66.18
LSD (0.05)	0.22	0.88	6.88	18.04
C.V. %	9.55	9.98	7.56	18.4
F-value	15.22	13.1	10.32	2.98
Mean	1.36	5.23	54	58.17

Note: Means followed by a common letter superscript within a column are non-significantly different, whereas the means followed by different letter superscripts within a column are significantly different based on Duncan's Multiple Range Test (DMRT) at P=0.05; NS: Non-Significant; SEM: Standard Error of Mean; CV: Coefficient of Variation; *,** and *** are significant at P=0.05, P=0.02 and P<0.00, respectively.

DISCUSSION

GROWTH OBSERVATIONS

HEIGHT OF PLANT

GA3 and NAA when applied together were found to stimulate the plant growth with significant effect on plant height, which was reported in Ud-deen (2009). Gibberellins accelerated cell elongation and cell division in sub apical meristem region increasing the plant height. This increase is the result of an increase in auxin in plant tissues by inducing the tryptophan conversion to IAA promoting cell division and cell elongation. Kanwar and Khandelwal (2013) and Singh (2004) reported the increase in plant height with the application of gibberellic acid by increasing the length of internodes of marigold. Auxins are also found to instigate the plant height elongation with the cell elongation, so the foliar spray of NAA at different growth stages at the right amount increases plant height. These influences of growth regulators are also corroborated by the findings of Krishnaprabu (2020), and Jyoti et al. (2018).

LEAVES PER PLANT

Auxins play an important role in cell division, vascular tissue differentiation, and apical dominance. Both NAA and Gibberellic acid play a role in auxin production within plant metabolism. These research findings are parallel with the findings of Rahman (2006), Jyoti et al. (2018), and Jyoti (2017).

YIELD AND YIELD CONTRIBUTING OBSERVATIONS

Sharma et al. (2013) reported that the use of plant growth regulators increased the stem diameter of the onion. GA3 and NAA actively affect cell division, cell elongation, and cell enlargement. This leads to an increase in height of the plant, number of leaves per plant and finally the onion diameter. This may be because of the increase in food materials available for the plant because of improved growth parameters. It leads to an increase in number of leaves, which in turn forms a scale of onion bulb thus, increases onion bulb diameter. This trait of plant growth regulators increases the length and number of leaves, which ultimately aids in increasing the bulbs' diameter. The studies of Rashid (2010) and Sharma et al. (2013) support this result.

The increase in the number of leaves, and other vegetative traits because of the use of PGR, increasing the photosynthates in the plant, increasing the number of bulb scales, which ultimately increases the fresh weight of the bulbs, also resonated from the work of Patel et al. (2010) and Tyagi (2007).

CONCLUSION

Different plant growth regulators have a significant effect on the growth and yield and yield attributing characters significantly. On the basis of our experiment, the best attributes were achieved from the application of NAA 150 mg/L at 3 leaf stage and GA3 150 mg/L at 7 leaf stage i.e. T12. Therefore, the application of NAA 150 mg/L at 3 leaf stage and GA3 150 mg/L at 7 leaf stage can be recommended for the onion to achieve the best yield and other best plant attributes. Since our research findings are based on the data from a single season, at least an additional season hassle of study is recommended. The findings will be useful for the local farmers as well as the future research initiatives.

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