WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

Influence of Gibberellic Acid and Bulb Priming on Growth and Seed Yield of Onion

Yubaraj Bhusal[1], and Binod Prasad Luitel[2]

[1]National Agriculture Technology Information Center (NATIC), NARC, Khumaltar; @: rbconus@gmail.com;
[2] National Horticulture Research Centre (NHRC), NARC, Khumaltar; @: binodsan@yahoo.com; ORCID: https://orcid.org/0000-0002-6958-4687,

ABSTRACT

Field experiments were carried out to study the influence of gibberellic acid (GA3) and bulb priming on growth and seed yield characters of onion cv. 'Red Creole' at HRS, Dailekh during two years (2018 and 2019). GA3 contained four treatment levels (50 ppm, 100 ppm, 150 ppm, and distilled water as control) and bulb priming consisted of three treatments levels (priming, bulb priming + foliar spray at 45 days after planting (DAP), and foliar spray at 45 DAP). Altogether, 12 treatments were assigned in factorial Randomized Complete Block Design (RCBD) with three replications. Combined analysis over the years showed that application of GA3 had significant effect on days to 50% bolting and flowering, plant vigor, plant and scape height, scape number/plant, umbel diameter, seed weight and seed yield. In contrast, priming showed the significant effect on umbel diameter, seed weight and seed yield. Onion bulb soaked with GA3 at 150 ppm exhibited the highest scape number (8.0/plant) and seed yield (1.6 mt/ha). Similarly, foliar spray of GA3 at 45 DAP also gave the highest seed weight (0.6 g) and seed yield (1.4 mt/ha). Therefore, onion bulb soaked with GA3 at 150 ppm along with foliar spray at 45 DAP can be recommended to increase the growth and seed yield characters of onion cv. 'Red Creole'.

Key words: Bulb priming, GA_3, Scape Height, Umbel Diameter, Yield

Introduction

Onion (*Allium cepa* L.) is an important bulb vegetable crops in the world and it belongs to Liliaceae family. It ranks at the third position among the production of vegetables after tomato and cabbage (Acharya and Shrestha, 2018). Onion is used as culinary purpose for making curries, salad, fried, boiled and soup etc. Onion has also medicinal properties and contain some compounds for health benefits that include anti-carcinogenic properties, anti-platelet activity, asthmatic and antibiotic effects (Griffiths, 2002). In Nepal, onion is cultivated in 20, 424 ha land with a total production of 2,84,926 mt with average productivity of 13.9 mt/ha (MoALD, 2020). The productivity of onion in Nepal is very low in comparison to India (16.18 mt/ha). Inadequate amount of quality seed at planting time is one of the major problem of low productivity in onion (Luitel et al., 2021). Besides, onion is a biennial crop and it requires two seasons for the seed production.

Onion cv. 'Red Creole' is a well-adapted open-pollinated most popular variety in Nepal due to its unique bulb characters as well good storability trait (Luitel et al., 2021). Onion bulb generally harvests in May at mid hills and stores at ordinary room condition for five months. These mother bulbs are used for onion seed production using bulb to seed method. The demand of 'Red Creole' seed has increased in the country and national production cannot meet the total seed demand of the country. We are dependent on private seed company since they are importing large amount of onion seed from abroad. Most of researches conducted so far in onion seed production in Nepal are related to bulb size standardization and planting density (Acharya et al., 2008), and nitrogen nutrition and bulb size (Shakya et al., 2018). Besides the mother bulb size and planting density factors, gibberellic acid (GA_3) also influences plant growth and increases seed yield. The effect of GA_3 on bulb development and seed production in onion has been well documented by previous researchers (Loper and Waller, 1982; Rabiowitch and Friedlander; 1991; Kokhar 2014; Thejeshwini et al, 2019 and Bista et al., 2022). But the concentration of GA_3 may differ the growth and seed characters of onion. Likewise, GA_3 influences growth by promoting elongation of stem and plant internodes. GA_3 promotes seed germination, leaf expansion, stem elongation and flowering initiation. Seedling treatment with GA_3 followed by foliar spray and their effect on plant growth and bulb yield has been studied by many researchers (Hye et al., 2002; Bista et al., 2022). However, research on bulb priming and foliar spray regarding on the seed production is limited. Treating with mother bulb with GA_3 alters the physiology of crop growth and might produce high seed yield. Thus, this study was done to investigate the effect of gibberellic acid and bulb priming on growth and seed yield characters of onion cv. 'Red Creole' at mid hill region of Nepal.

Materials and Methods

Study site and plant materials

This experiment was conducted at HRS, Dailekh (28°13′6.18″N, 83°58′27.72″E, and 1,255 m asl) during two years (2018 and 2019). Onion cv. 'Red Creole',

a popular variety at mid-hill of Nepal was used in this study. The climate was sub-tropical type and experimental soil was loamy type. To conduct the experiment, onion cv. 'Red Creole' bulbs produced at HRS, Dailekh was used in both the years. In this experiment, four levels of GA_3 (50 ppm, 100 ppm, 150 ppm and distilled water as control) and three levels of bulb priming (bulb priming, bulb priming + foliar spray at 45 DAP, and foliar spray at 45 DAP) were used as treatment. Altogether, 12 treatments were allotted in factorial RCBD with three replications. 1 g of GA_3 was dissolved in a small quantity of alcohol. Then, distilled water was added to make the volume one liter to get 1000 ppm stock solution. Then, 50, 100, and 150 ppm were prepared using stock solution in five liters of distilled water. Distilled water was also used as control treatment. Before planting, uniform and medium size (45.0 mm - 60.0 mm) non-sprouted mother bulbs were chosen for the hormonal treatment. Then, bulbs were dipped in each GA_3 solution for 24 h. Field was prepared by ploughing and then, land was levelled by hoeing. A recommended dose of 100 kg N, 80 kg P_2O_5 and 60 kg K_2O/ha along with 25 tonnes FYM/ha was applied in the form of urea, diammonium phosphate (DAP) and murate of potash, respectively. Half amount of nitrogen, and all amount of phosphorous, potassium, and compost were used as basal dose during field preparation and remaining half amount of nitrogen was top-dressed at 45 days after bulb emergence. Treated bulb was manually planted at a depth of 5.0 cm in rows with the spacing of 45 cm x 30 cm, and plot size was maintained at 4.5 m^2. The distance between two plots was 50 cm. Bulbs were planted on Oct., 22 in both years (2018 and 2019) and each plot contained 30 mother bulbs. Intercultural practices such as earthening-up, weeding, irrigation and plant protection measures were applied as per the recommendation of onion cultivation (Chalise and Poon, 2015).

Observations and data analysis

Phenotypic observations including days to 50% bolting and flowering, plant vigor, plant height (cm) scape height (cm), scape number/plant, umbel diameter (mm), seed weight and seed yield (mt/ha) were taken from each plot. Days to 50% bolting was recorded as the number of days from date of planting up to when 50% of the plants in a plot produced flower stalk. Days to 50% flowering was recorded as the number of days from date of planting up to when 50% of the plants in each plot produced flowers. Plant vigor was taken subjectively by scale (1-5) scale where 1 = poor, 2 = fair, 3 = good, 4 = very good and 5 = Excellent. Plant height (cm) was measured on five plants from the soil surface to the tip of each plant after development of umbels of the plant and then, it was averaged. Scape height (cm) was measured from randomly selected five plants from the central rows from each plot at flowering stage and averaged it. Number of scape was counted on five plants from each plot at flowering stage and averaged it. Umbel diameter (mm) was measured using a Vernier caliper two times measuring in two directions (north-south and east to west). Seed weight/plot was measured after all the umbels harvested, dried and threshed and adjusted to a moisture content of 8%. Seed yield (mt/ha) was estimated from seed weight/plot and converted to hectares in metric tonnes. The collected data were subjected to Analysis of Variance (ANOVA) using GenStat Release 10.3 DE Software (VSN International Ltd., UK) and simple correlation was done to determine the association of traits by using Pearson analysis.

Results and Discussion

Effect of GA_3 and bulb priming in growth characters

Gibberellic acid effect on days to 50% flowering was highly significant ($p \leq 0.01$). But year showed significant variation on days to 50% bolting. The combined mean showed that bulb soaked with distilled water (control treatment) exhibited the delayed (132.0 days) bolting as compared to the 100 and 150 ppm GA_3 applied but the means were not significantly different with treatment of 50 ppm GA_3. Bulb treated with 100 and 150 ppm GA_3 showed earlier flowering (158.0 days) than others but it showed statistically at par with 50 ppm GA_3. The highest plant vigor (5.0) was observed in the plants treated with 150 ppm GA_3 but the lowest vigor (3.0) was noticed in control. Geetharani et al. (2008) reported the earliest flowering at onion plants at 100 ppm GA_3 foliar spray treatment which confirmed our result. Rabinowitch et al. (1991) found that application of GA_3 at 500 to 1000 ppm enhanced flowering in normal onion genotypes. Shaikh et al. (2002) reported that application of 50 ppm GA_3 gave the highest plant vigor values. But Helaly et al. (2016) found 1000 ppm GA_3 as the best treatment for the earliest bolting. But in this study, application of 150 ppm GA_3 gave significantly higher plant vigor than others. High GA_3 might be promoted the stem elongation and internodes of plant that might produce high plant vigor. Priming effect on days to 50% bolting, days to 50% flowering and plant vigor was non-significant. Interaction effect between GA_3 and priming in all the traits was non-significant (Table 1).

Table 1. Effect of gibberellic acid and bulb priming on growth characters of onion during 2018 and 2019 at HRS, Dailekh

Treatment	Days to 50% bolting		Mean	Days to 50% flowering		Mean	Plant vigor (1-5 scale)		Mean
GA_3 (ppm)	2018	2019		2018	2019		2018	2019	
50	131.0	127.0	129.0	157.0	161.0	159.0	4.0	4.0	4.0
100	131.0	126.0	128.0	157.0	159.0	158.0	3.0	5.0	4.0
150	131.0	126.0	128.0	156.0	160.0	158.0	4.0	5.0	5.0
Control	133.0	131.0	132.0	161.0	162.0	162.0	3.0	4.0	3.0
F-Test			**			**			**
LSD (0.05)			1.52			1.91			0.44
Priming (P)									
Bulb priming (BP)	132.0	128.0	130.0	158.0	161.0	160.0	3.0	4.0	4.0
BP + foliar spray	131.0	127.0	129.0	157.0	160.0	159.0	4.0	4.0	4.0
Foliar spray	132.0	127.0	129.0	158.0	160.0	159.0	4.0	4.0	4.0
Mean	131.25	127.50	129.38	157.7	160.42	159.07	3.55	4.33	3.94
F-Test			NS			NS			NS
LSD (0.05)			1.30			1.65			0.38
CV (%)			1.7			1.8			16.8
GA_3 x P			NS			NS			*

^{NS} and ** indicate non-significant and highly significant at 5% and 1% level, respectively.

GA_3 effect on plant and scape height was significant (≤ 0.05). Average plant height was maximum (121.42 cm) in 2018 but it was not significantly different with the year 2018. The combined mean showed the highest (123.1 cm) plant height at 100 ppm GA_3 and the lowest (117.0 cm) was in control. Similarly,

the highest scape height (118.8 cm) was measured in the year 2019. Islam et al. (2005) reported the highest plant height at 75 ppm GA_3 which contradicts to our findings. Sharma et al. (1999) reported that the application of GA_3 increased in plant height in onion plant. The highest scape height (112.6 cm) was measured at 50 ppm GA_3 applied plants and the lowest (108.8 cm) was measured at 150 ppm GA_3 applied plot. In the study of Helay et al. (2016), they reported that 500 ppm GA_3 produced the highest scape height. GA_3 has physiological action and it also enhances vegetative growth (Islam et al., 2007). The highest scape number (8.0/scape) was counted in the plants of 150 ppm GA_3 soaked bulb but the lowest scape number (5.0/plant) was counted in control. GA_3 promoted the plant growth thereby increased the number scape/plant in GA_3 soaked bulbs and similar results were reported by Nehra et al. (1992). Priming had non-significant effect on plant and scape height, and scape number/plant. The interaction effect between GA3 and priming was non-significant (Table 2).

Table 2. Effect of gibberellic acid and bulb priming on growth characters of onion during 2018 and 2019 at HRS, Dailekh

Treatment	Plant height (cm)		Mean	Scape height (cm)		Mean	Scape/plant (no.)		Mean
GA_3 (ppm)	2018	2019		2018	2019		2018	2019	
50	120.5	117.6	119.1	107.7	117.4	112.6	6.0	6.0	6.0
100	125.4	120.8	123.1	108.0	114.1	111.1	6.0	6.0	6.0
150	123.3	117.5	120.4	104.6	113.1	108.8	8.0	7.0	8.0
Control	116.3	117.8	117.0	105.1	118.8	111.9	5.0	5.0	5.0
F-Test			*			*			**
LSD (0.05)			4.34			3.34			0.55
Priming (P)									
Bulb priming (BP)	121.3	116.2	118.8	106.2	115.2	110.7	5.0	6.0	6.0
BP + foliar spray	120.8	118.3	119.6	105.5	117.1	111.3	6.0	6.0	6.0
Foliar spray	122.0	120.8	121.4	107.3	115.3	111.3	6.0	6.0	6.0
Mean	121.42	117.8	119.9	106.37	115.89	111.13	6.11	6.23	6.17
F-Test			NS			NS			NS
LSD (0.05)			3.75			3.97			0.481
CV (%)			5.4			6.1			13.4
GA_3 x P			NS			NS			NS

NS, * and ** indicate non-significant, significant and highly significant at 5% and 1% level, respectively.

Effect of GA_3 and bulb priming on seed yield

Application of GA_3 showed highly significant differences umbel diameter, seed weight and seed yield. The highest umbel diameter (92.4 mm) was measured with 150 ppm GA_3 but the lowest (84.7 mm) was recorded in control treatment. Application of GA_3 tend to increase cell division followed by rapid plant growth which resulted enlarge umbel diameter and Rashid (2010) reported the similar result. The average seed weight was highest (0.7 g/plot) at150 ppm GA_3 and the lowest (0.4 g/plot) was measured in control. Likewise, the highest seed yield (1.6 mt/ha) was recorded in 150 ppm GA_3 and the lowest (1.1 mt/ha) was recorded in control. Priming had a significant effect on umbel diameter. Foliar spray at 45 DAP showed the highest umbel diameter (89.4 mm) but it showed statistically similar to bulb priming and bulb priming + foliar spray treatments at 45 DAP. Likewise, bulb priming + foliar spray and foliar spray of GA_3 at 45 DAP significantly increased the seed weight (0.6 g) but only bulb priming showed the lowest seed weight (0.5 g/plot). Increased growth rate of plants and total seed yield in onion using GA_3 has also been reported by Passam et al (2008). Geetharani et al. (2008) also reported that foliar spray of 100 ppm GA_3 gave high seed yield in onion. Priming had highly significant ($p \leq 0.01$) effect in seed yield. Foliar spray of GA_3 at 45 DAP showed the highest seed yield (1.4 mt/ha) but the lowest seed yield (1.1 mt/ha) was measured in control. Interaction effect between GA_3 and priming was non-significant for all the traits (Table 3).

Table 3. Effect of gibberellic acid and bulb priming on umbel diameter, and seed yield of onion during 2018 and 2019 at HRS, Dailekh

Treatment	Umbel dia.(mm)		Mean	Seed weight/plot (g)		Mean	Seed yield (t/ha)		Mean
GA_3 (ppm)	2018	2019		2018	2019		2018	2019	
50	98.7	76.9	87.8	0.6	0.4	0.5	1.4	1.1	1.3
100	102.6	78.1	90.3	0.6	0.5	0.6	1.5	1.4	1.4
150	105.3	79.6	92.4	0.7	0.7	0.7	1.7	1.6	1.6
Control	97.7	71.7	84.7	0.4	0.4	0.4	1.1	1.0	1.1
F-Test			**			**			**
LSD (0.05)			3.34			0.03			0.09
Priming									
Bulb priming (BP)	101.0	75.2	88.2	0.6	0.5	0.5	1.4	1.2	1.3
BP + foliar spray	101.2	76.6	88.9	0.6	0.5	0.6	1.4	1.2	1.3
Foliar spray	100.9	77.9	89.4	0.6	0.6	0.6	1.5	1.4	1.4
Mean			88.05	0.59	0.51	0.56	1.4	1.3	1.39
F-Test			*			**			**
LSD (0.05)			0.53			0.03			0.08
CV (%)			5.6			10.4			6.8
GA_3 x Priming			NS			NS			NS

NS, * and ** indicate non-significant, significant and highly significant at 5% and 1% level.

Phenotypic association among the traits

Days to 50 % bolting had a significant moderate positive correlation with umbel diameter (r = 0.45**) but days to 50% flowering showed a highly significant negative correlation with plant height (r = 0.44**), umbel diameter (r=-0.49**) and seed yield (r = -0.44**). But plant vigor showed the significant positive correlation with scape height and scape number/plant (r=0.42**). Scape height exhibited a highly significant negative association with umbel diameter (r = -0.55**). In contrast, scape number/plant showed highly significant positive correlation with seed weight/plant (r = 0.51**) and seed yield (r = 0.50**). In the

study of Tesfaye et al. (2018), they had also reported the positive association of umbel diameter and seed weight with seed yield and our study also showed the similar results. Likewise, the association between seed weight/plot and seed yield was highly significant (Table 4).

Table 4. Pearson correlation coefficient of growth and yield attributes of onion during 2018 and 2019

Variables	DFB	DAFF	PLVIG	PHT	SHT	SPPT	UDIA	SWPPT	SYLD
DFB	1.0	0.19	-0.52**	-0.12	-0.36**	-.19	0.45**	-0.124	-0.13
DAFF		1.0	-0.23	-.44**	0.22	-.29*	-.49**	-.44**	-.44**
PLVIG			1.0	0.22	.34**	0.42**	-0.22	0.20	0.21
PHT				1.0	0.19	0.111	0.27*	0.23*	0.24*
SHT					1.0	-0.13	-0.55**	-.36**	-0.33**
SPPT						1.0	0.14	0.51**	0.50**
UDIA							1.0	0.43**	0.42**
SWPPT								1.0	0.99**
SYLD									1.0

*and ** indicate significant at 0.05 and 0.01 levels, respectively. DFFB = Days of fifty percent bolting, DAFF = Days to fifty percent flowering, PLVIG = Plant vigor (1-5 scale), PHT = Plant height, SHT = Scape height (cm), SPPT = Scape/plant (no.), UDIA = Umbel diameter (mm), SWPPT = Seed weight/plot and SYLD = Seed yield (mt/ha)

Conclusion

This research assessed the effect of GA_3 and bulb priming on growth and seed yield characters of onion. GA_3 showed significant effect on days to 50% bolting and flowering, plant vigor, plant and scape height, scape/plant (no.), umbel diameter, seed weight and seed yield but priming had significantly affected on umbel diameter, seed weight and yield. Umbel diameter showed the phenotypic association with seed weight/plant and seed yield. Umbel diameter or size is one of major trait of seed production and selection of this trait can improve the seed yield. Application of 150 ppm GA_3 with foliar spray at 45 DAP can be significantly increased growth characters and seed yield in onion.

ACKNOWLEDGEMENT

The authors thank to NARC for the financial support from project titled "Production of Improved Technologies in Vegetable Crops, No. 325). The authors also thank to staffs of HRS, Dailekh for their kind cooperation during the field experimentation.

REFERENCES

Acharya, B., & Shrestha, R. K. (2018). Nitrogen Level and Irrigation Interval on Mitigating Stemphylium Blight and Downy Mildew in Onion. *International Journal of Applied Sciences and Biotechnology* 6(1): 17-22.

Acharya, U.K., Gautam, I.P., Subedi, G.D. & G.B. Pun. (2008). Standardization of bulb size and planting density on seed production of onion in Mid Westerm hills of Nepal. *Journal of Himalayan College of Agricultural Sciences and Technology* 6:16-22.

Bista, D., Sapkota, D., Paudel, H. & Adhikari, G. (2022). Effect of foliar application of growth regulators on growth and yield of onion (Allium cepa). *Int. J. Hort. Sci. Technolo*. 9(2): 247-254.

Chalise, B. & Pun,T.B. (2015). Nepalma Kheki Garine Mukhya Tarkari Baliharuko Biu Utpadhan Prabidhi (Nepali Version). Nepal Agricultural Research Council, Horticulture Research Station, Kimugaon, Dailekh

Geetharani, P., Manivannan, M.I., & Ponnuswamy, A.S. (2008). Seed production of onion as influenced by the application of growth regulators and nutrients. *The Asian Journal of Horticulture* 3(2): 301-303.

Griffiths, G. (2002). Onions-A global benefit to health. John Wiley and Sons, Ltd.

Helaly, A.A., Abdelghafar, M.S., Al-Abd, M.T. & Alkharpotly, A.A. (2016). Effect of soaked *Allium cepa* L. bulbs in growth regulators on their growth and seeds production. *Adv Plants Agric Res* 4 (3): 00139

Hye, M.A., Haque, M.S. & Karim, M.A. (2002). Influence of growth regulators and their time of application on yield of onion. *Pakistan Journal of Biological Sciences* 5(10): 1021-1023.

Islam, A.K.M.M. & Mondal, M.F. (2005). Effects of planting date and GA3 on growth, yield and quality of onion seeds grown from sets. *J. Bangladesh Agril. Univ*. 3(1): 7-12.

Islam, S., Islam, M.O., Alam, M.N., Ali, M.K., & Rahman, M.A. (2007) Effect of plant growth regulator on growth, yield and yield components of onion. *Asian J of Plant Sci* 6(5): 849-853.

Kokhar, K.M. (2014). Flowering and seed development in onion-A review. *Open Access Library Journal* 1:e1049.http://dx.doi.org/10.4236/oalib.1101049

Loper, G.M., & Waller, G.D. (1982). GA3 increased bolting and seed production in late-planted onions. *Hort Science* 17: 922-923.

Luitel, B.P., Bhandari, B.B., Gautam, I.P. & Pradhan, N.G. (2021). Evaluation of onion genotypes for bulb yield and storability at Dailekh, Karnali Province, Nepal. Proceeding of 12th National Horticulture Seminar, March 4-5, Kirtipur, Kathmandu.

MoALD. (2020). Statistical information on Nepalese agriculture, 2076/77 (2019/20). Ministry of Agriculture and Livestock Development, Planning and Development Cooperation Coordination Division. Singhdurbar, Kathmandu, Nepal.

Nehra, B.K., Pandita, M.L. & Singh, K. (1992). A note on the effect of various chemicals on bolting and seed yield of onion (Allium cepa L.) under seed to seed method of seed method of seed production. *Haryana J. Hort. Sci*., 21 (1-2): 103-105.

Passam, H.C., Koutri, A.C. & Karapanos, I.C. (2008) The effect of chlormequat chloride (CCC) application at the bolting stage on the flowering and seed production of lettuce plants previously treated with water or gibberellic acid (GA_3). *Sci Hort*.116: 117-121.

Rabinowitch, H.D., & Friedlander. B. (1991). Dwarf Flower Stalk in Onion: Characterization, Genetic Control, and Physiological Response to Ethephon and Gibberellic Acid. *Journal of American Society for Horticultural Science* 116(3): 574-579.

Rashid, M.H.A. (2010). Effect of Sulphur and GA3 on the growth and yield of onion. *Progress Agric* 21 (1&2): 57-63.

Shaikh, A.M.B. Vyakaranahal, S., Shekhargouda, M., & Dharmati, P.R. (2002). Influence of bulb size and growth regulators on growth, seed yield and quality of onion cv. Nasik Red. *Seed Res* 30 (2): 223 -229.

Shakya, S.M., Basnet M., Shrestha, S.M. & Mishra, K. (2015). Effect of nitrogen and off season bulb size on onion seed production. *J. Inst. Agric. Anim. Sci*. 33-34: 41-46.

Sharma, N., Kaur, N. & Gupta, A. K. (1999). Effects of gibberellic acid and chlorocholine chloride on tuberization and growth of potato (*Solanum tuberosum* L.). *J Sci Food Agric* 78(4): 466-470.

Tesfaye M., Belew D., Dessalegn & Shumye, G. (2018). Effect of planting time on growth, yield components, seed yield and quality of onion (*Allium cepa* L.) at Tehuledere district, northeastern Ethipia. *Agric and Food Secur* 7:28.

Thejeshwini, B., Rao, A.M., Nayak M.H. & Sultana, R. (2019). Effect of seed priming on plant growth and bulb yield in onion (*Allium cepa* L.). *Int. J. Curr. Mic*robiol. *App. Sci*. 8:1-7.