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The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(12): 3039-3042

www.thepharmajournal.com
Received: 15-09-2022
Accepted: 18-10-2022

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Study of PGRs on economics and storage of onion (*Allium cepa* L.)

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Abstract
The experiment was carried out to analyse the effect of different plant growth regulators on yield, economics and storage attribute of onion 2018 and 2019 in Vegetable Research Farm, Navsari Agricultural University, Navsari, Gujarat. The experiment was conducted in three replications using randomized block design (RBD), which included 12 treatments. By analysing the data, results inferred that GA_3 @ 25 ppm recorded highest bulb yield per net plot (19.97 kg), total bulb yield (47.55 t/ha), marketable bulb yield (42.70 t/ha), benefit cost ratio 2.23 with minimum percentage of physiological loss in weight i.e., 4.00% at 30 DAS and 6.17% at 60 DAS.

Keywords: Bioregulators, economics, GA_3, marketable yield, NAA, onion etc.

Introduction
Onion (*Allium cepa* L.) is an important and indispensable item in every kitchen as condiment cum vegetable in India. It is an important crop in all continents and commercially cultivated in various countries. It is one of the important underground bulbous vegetable crops of Alliaceae family and is said to be native of Central Asia and Mediterranean region (Mc Collum, 1976) [2]. Plant bioregulators called as magic chemicals are new generation agrochemicals, when added in small quantity, modify the natural growth regulatory systems right from seed germination to senescence in several vegetable crops and also regulate and modify various physiological processes within the plant and they help to increase the yield (Weaver, 1972) [1].

Experimental Section
The field experiment was carried out at the vegetable research farm, Regional Horticultural Research Station of the Navsari Agricultural University, Navsari, Gujarat, India during *Rabi* 2018 and 2019 on cv. Gujarat Junagadh Red Onion 11 to investigate the response of plant bioregulators on yield attributes of onion. The experiment was conducted in RBD with three replications, which included 12 treatments namely, T_1: GA_3 25 mg l^{-1}, T_2: GA_3 50 mg l^{-1}, T_3: GA_3 75 mg l^{-1}, T_4: NAA 25 mg l^{-1}, T_5: NAA 50 mg l^{-1}, T_6: NAA 75 mg l^{-1}, T_7: GA_3 25 mg l^{-1} + NAA 25 mg l^{-1}, T_8: GA_3 25 mg l^{-1} + NAA 50 mg l^{-1}, T_9: GA_3 25 mg l^{-1} + NAA 75 mg l^{-1}, T_{10}: GA_3 50 mg l^{-1} + NAA 50 mg l^{-1}, T_{11}: GA_3 75 mg l^{-1} + NAA 75 mg l^{-1} and T_{12}: Control. The foliar sprays were made at 30 days after transplanting during morning hours to avoid the dehydration effect. For recording different observations, ten plants of onion from each net plot area were selected randomly and tagged with labels.

Results and Discussion
Yield Parameters
Data presented in Table 1 clearly indicated that yield significantly influenced by the different treatments of growth regulators at various concentrations. Looking to the mean of pooled analysis, the results showed that the application of GA_3 25 mg l^{-1} (T_1) recorded maximum bulb yield per net plot (19.97 kg), maximum total bulb yield (47.55 t ha^{-1}) and highest marketable bulb yield (42.70 t ha^{-1}) which was superior over rest of the treatments followed by T_{10} (GA_3 50 mg l^{-1}+ NAA 50 mg l^{-1}). Whereas, minimum bulb yield per net plot (14.22 kg), lowest total bulb yield (33.85 t ha^{-1}) and lowest marketable bulb yield (30.81 t ha^{-1}) were recorded with T_{11} (GA_3 75 mg l^{-1} + NAA 75 mg l^{-1}).

Table 1: Effect of different bioregulators on bulb yield per net plot (kg), total bulb yield (t ha^{-1}) and marketable bulb yield (t ha^{-1}) of onion

Treatments	Bulb yield per net plot (kg)			Total bulb yield (t ha^{-1})			Marketable bulb yield (t ha^{-1})		
	2018	2019	Pooled	2018	2019	Pooled	2018	2019	Pooled
T_1: GA_3 25 mg l^{-1}	15.46	24.48	19.97	36.81	58.29	47.55	32.56	52.84	42.70
T_2: GA_3 50 mg l^{-1}	13.31	21.03	17.17	31.68	50.07	40.88	28.88	47.65	38.26
T_3: GA_3 75 mg l^{-1}	13.17	20.94	17.05	31.36	49.87	40.62	28.75	46.62	37.69
T_4: NAA 25 mg l^{-1}	13.14	20.80	16.97	31.29	49.52	40.40	28.15	46.46	37.31
T_5: NAA 50 mg l^{-1}	12.89	20.36	16.62	30.69	48.47	39.58	27.86	45.35	36.61
T_6: NAA 75 mg l^{-1}	12.66	20.18	16.42	30.14	48.04	39.08	27.78	44.48	36.13
T_7: GA_3 25 mg l^{-1} + NAA 25 mg l^{-1}	12.26	19.26	15.76	29.20	45.85	37.52	27.03	41.67	34.35
T_8: GA_3 25 mg l^{-1} + NAA 50 mg l^{-1}	11.96	18.62	15.29	28.48	44.34	36.41	26.76	41.48	34.12
T_9: GA_3 25 mg l^{-1} + NAA 75 mg l^{-1}	11.68	18.48	15.08	27.81	44.00	35.91	24.06	40.52	32.29
T_{10}: GA_3 50 mg l^{-1} + NAA 50 mg l^{-1}	13.65	21.32	17.49	32.51	50.76	41.64	29.13	47.80	38.47
T_{11}: GA_3 75 mg l^{-1} + NAA 75 mg l^{-1}	10.19	18.25	14.22	24.25	43.46	33.85	22.13	39.50	30.81
T_{12}: Control	12.07	19.15	15.61	28.74	45.60	37.17	26.97	41.52	34.25
Year Mean	12.70	20.24	16.47	30.25	48.19	39.22	27.50	44.66	36.08
S. Em. ±	0.75	1.14	0.62	1.77	2.71	1.49	1.71	2.58	1.44
C.D. at 5%	2.19	3.34	1.77	5.20	7.95	4.22	5.00	7.57	4.09
C.V. %	10.16	9.74	10.11	10.16	9.74	10.11	10.74	10.00	10.50
YT: S. Em. ±			0.96			2.29			2.19
YT: C. D. at 5%			NS			NS			NS

The result demonstrated that GA_3 had significant influence on yield parameters of onion. The increase in bulb yield was mainly attributed due to increase in bulb weight per plant and bulb diameter. Increase in bulb yield with GA_3 application might be due to the fact that GA_3 initiate the physiological process and permeability of cell to produce more food for reserve. Growth regulators influenced maximum number of scales per bulb thus increasing in the size of bulb and ultimately having maximum marketable bulb yield. It can be concluded that GA_3 was found most effective in enhancing the yield. Similar results observed by Nirmal *et al.* (1994) [8], Singh *et al*. (1995) [18] and Maurya and Lal (1987) [7], Shakhda and Gajipara (1998) [13], Anant and Maurya (2001) [3], Hye *et al.* (2002) [5], Poonam *et al.* (2002) [11], Subimal *et al.* (2003) [17], Tiwari *et al.* (2003) [19], Das *et al*. (2006) [4], Islam *et al.* (2007) [6], Tyagi and Yadav (2007) [20], Rashid (2010) [12], Sharma *et al.* (2013) [15] and Omesh *et al*. (2018) [9] in onion and Singh *et al.* (2014) [16] in garlic.

Economics

The data presented in Table 2 revealed that among the different combination of treatments T_1 (GA_3 25 mg l^{-1}) observed the highest net profit 29, 4005 ₹ ha^{-1} with B CR value 2.23 of as compared to rest of the treatments followed by T_2 (2.01). Whereas, treatment T_{11} (GA_3 75 mg l^{-1} + NAA 75mg l^{-1}) recorded the lowest net realization 142395 ₹ ha^{-1} with lowest B CR value of 1.12.

The economics are worked out for different treatments revealed that GA_3 25 mg l^{-1} as foliar spray registered the highest net realization of 29, 4005 ₹ ha^{-1} with B CR value 2.23. These results are in agreement with the findings of Patel *et al.* (2010) [10] in onion.

Table 2: Economics of different bioregulators treatments (₹ ha^{-1})

Treatments	Marketable yield (t ha^{-1})	Treatment cost (₹)	Operational cost (₹)	Total cost (₹)*	Gross return (₹)	Net return (₹)	BCR (₹)
T_1: GA_3 25 mg l^{-1}	42.70	1325	103616	131629	425634	294005	2.23
T_2: GA_3 50 mg l^{-1}	38.26	2650	103616	130179	391660	261481	2.01
T_3: GA_3 75 mg l^{-1}	37.69	3975	103616	131147	373734	242587	1.85
T_4: NAA 25 mg l^{-1}	37.31	56	103616	126991	360232	233241	1.84
T_5: NAA 50 mg l^{-1}	36.61	112	103616	126609	366444	239835	1.89
T_6: NAA 75 mg l^{-1}	36.31	167	103616	126477	343845	217368	1.72
T_7: GA_3 25 mg l^{-1} + NAA 25 mg l^{-1}	34.72	1381	103616	126697	332882	206185	1.63
T_8: GA_3 25 mg l^{-1} + NAA 50 mg l^{-1}	34.12	1437	103616	126378	327310	200932	1.59
T_9: GA_3 25 mg l^{-1} + NAA 75 mg l^{-1}	32.29	1492	103616	125289	323239	197950	1.58
T_{10}: GA_3 50mg l^{-1} + NAA 50 mg l^{-1}	38.47	2762	103616	130422	345044	244622	1.88
T_{11}: GA_3 75 mg l^{-1} + NAA 75 mg l^{-1}	30.81	4142	103616	127014	269409	142395	1.12
T_{12}: Control	34.25	0	103438*	124844	310726	185882	1.49

(Note: * Excluding treatment cost application; Total cost*: 1/16th of yield appraisal for land revenue)

Storage Studies

In pooled analysis, the results showed significant at 30 days after storage and non-significant at 60 DAS. At 30 DAS, minimum PLW (4.00%) was noted in T_1 (GA_3 25 mg l^{-1}) which was remain at par with the treatment T_{10}. Whereas, maximum weight loss (7.17%) was observed with the treatment T_2 and T_4. The interaction of year × treatment was found non-significant at 30 DAS and significant at 60 DAS (Table 3). In first 30 days of storage, the weight loss was lowest in bulbs sprayed with GA_3 @ 25 ppm. At 60 DAS, the weight loss was highest in control whereas low rate of weight loss in bulbs treated with GA_3 @ 25 ppm.

Effect of various treatments showed significant difference in the physiological loss in weight during the storage of bulbs at 30 and 60 DAS. In first 30 days of storage, the weight loss was lowest in bulbs sprayed with GA_3 @ 25 ppm. At 60 DAS,

the weight loss was highest in control whereas, low rate of weight loss in bulbs treated with GA_3 @ 25 ppm. Shoemaker (1947) [14] reported that thick neck bulbs are more prone to sprouting due to greater access of oxygen and moisture to central growing point which ultimately lead to loss in marketable quality of bulb.

Table 3: Effect of bio regulators on physiological loss in weight (30 and 60 DAS)

Treatments	Physiological loss in weight (PLW)					
	30 DAS			60 DAS		
	2018	2019	Pooled	2018	2019	Pooled
T_1: GA_3 25 mg l^{-1}	4.33	3.67	4.00	7.67	4.67	6.17
T_2: GA_3 50 mg l^{-1}	8.00	6.33	7.17	12.67	7.67	10.17
T_3: GA_3 75 mg l^{-1}	6.00	8.00	7.00	9.00	8.67	8.83
T_4: NAA 25 mg l^{-1}	7.00	7.33	7.17	10.00	10.00	10.00
T_5: NAA 50 mg l^{-1}	6.67	7.33	7.00	10.67	8.00	9.33
T_6: NAA 75 mg l^{-1}	5.67	7.00	6.33	8.00	8.33	8.17
T_7: GA_3 25 mg l^{-1} + NAA 25 mg l^{-1}	5.67	5.67	5.67	8.33	7.67	8.00
T_8: GA_3 25 mg l^{-1} + NAA 50 mg l^{-1}	5.67	5.33	5.50	9.67	6.67	8.17
T_9: GA_3 25 mg l^{-1} + NAA 75 mg l^{-1}	6.67	7.33	7.00	10.00	6.67	8.33
T_{10}: GA_3 50mg l^{-1} + NAA 50 mg l^{-1}	6.67	5.00	5.83	10.00	7.00	8.50
T_{11}: GA_3 75 mg l^{-1} + NAA 75 mg l^{-1}	4.33	6.00	5.17	8.33	7.00	7.67
T_{12}: Control	6.33	7.00	6.67	10.67	8.33	9.50
Year Mean	6.08	6.33	6.21	9.58	7.56	8.57
S. Em. ±	0.71	0.51	0.47	0.72	0.77	0.81
C.D. at 5%	NS	1.50	1.33	2.11	2.25	NS
C.V. %	20.08	13.95	17.17	12.97	17.61	15.03
YT: S. Em. ±			0.62			0.74
YT: C. D. at 5%			NS			2.12

Acknowledgements

I wish to express my sincere gratitude to Dr. S. N. Saravaiya, Associate Professor, Department of Vegetable Science and who supported me for providing an opportunity to do my project work in Vegetable Research Farm, Regional Horticultural Research Station, Navsari Agricultural University, Gujarat during the year 2018 to 2019.

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