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Economics and yield response of onion to plant hormones and age of seedling

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Abstract
The response of three seedling age (6, 8 and 10 week old seedling) of onion cultivar N-53 was studied against different plant hormonal treatments *viz.*, cycocel (500 & 1000ppm), ethephon (2000 & 2500ppm) and paclobutrazol (1000 & 2000ppm) in factorial RBD replicated thrice during *Rabi* season of 2014-2015. The results showed that 8 week old seedlings outperformed other aged seedlings with highest yield, quality, plant establishment and economics. Data with respect to yield attributes clearly pointed out that 8 week old seedlings performed better and showed statistically higher bulb yield (9.54kg/plot), total bulb yield (212.06q/ha) and marketable yield (205.40q/ha) over the 10 and 6 week old seedling. All plant hormones significantly reduced vegetative growth as compared to control. Amongst them, paclobutrazol @ 2000ppm was found statistically superior in terms of per plot bulb yield (8.57 kg/plot), total bulb yield (190.78q/ha), marketable yield (181.83q/ha) and minimum unmarketable bulb yield of (8.53 q/ha) as compared to other treatments. Interactive effect of paclobutrazol @ 2000ppm sprayed on 8 week old seedlings (A_2P_2) produced significantly higher marketable yield (279.50q/ha). Economics of the experiment showed maximum B: C ratio in 8 week old seedling with 2000 ppm paclobutrazol (4.4) with higher net returns of (₹ 3, 46,869) as compared to other treatment as well as control.

Keywords: B:C ratio, economics, net return, plant hormones, seedling age, yield

Introduction
Onion (*Allium cepa* L.) is one of the important bulb crops belonging to family Alliaceae and has gained the importance of a cash crop in recent years. India is the second largest producer of onion in the world after China. During 2013-14, onion occupied 12.03 lakh hectares with production of 19.40 lakh MT in India after China and third in export (18.22 lakh MT) after Netherlands and Spain, with foreign exchange earnings of 1966.6 crores (Anonymous, 2014). The major onion growing states are Maharashtra, Bihar, Karnataka, Gujarat, Andhra Pradesh, Uttar Pradesh, Odisha, Madhya Pradesh, Rajasthan and Haryana. Onion is characterized by its distinctive flavour and pungency, which is the due to sulphur containing compounds Allylpropyl-disulphide, found in the scales of the bulb.

The cultivation of onion is highly technical and depends on environmental conditions such as photoperiod and temperature as well as growth rate and number of days to maturity (Steer, 1980). The factors like seedling age at the time of transplanting, hormonal imbalance of the plant, *etc.* affect the yield of onion. Plant hormones have an interesting role particularly in modern agriculture (Ashraf *et al.*, 2010) [3] to improve and accelerate plant physiology. The knowledge of their metabolic and transport pathways will lead to new opportunities to manipulate plant growth. However, their use in crop like onion was not realized on commercial basis. Relatively slow growth and early cessation of cell elongation are the characteristics that can be directly linked to scape formation. Their role as anti-gibberellins could be utilized in various growth processes in onion such as bulbing and senescence (Levy *et al.,* 1972) [7]. Keeping in view the present investigation has been undertaken to determine the relationship of seedling age and exogenous application of plant growth regulator on economics and yield of onion.

Material and Methods
The present study was carried out at Vegetable Research Farm, Division of Vegetable Science and Floriculture, SKUAST, Chatha, Jammu (J&K) situated at $33^0 55'$ N latitude and $74^0 58'$ East longitude with altitude of 296 meter above mean sea level during *Rabi* season of 2014-2015. The experiment was laid out in a factorial randomized block design (RBD) with three replications comprising of three seedling age (6, 8 and 10 week old) and seven plant hormonal treatments *viz.*, cycocel 500ppm (C_1), cycocel 1000ppm (C_2), ethephon 2000ppm (E_1), ethephon 2500ppm (E_2), paclobutrazol 1000ppm (P_1), paclobutrazol 2000ppm (P_2) and

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Control-distilled water spray (C_0). The seedlings of N-53 variety were transplanted at a spacing of 15cm between rows and 10cm between plants in 2.25 x 2.0m sized plots accommodating 300 plants per plot. Fertilization, other cultural practices and need based plant protection measures were followed as recommended for commercial production. Three consecutive spray of each plant hormone was made at critical phases of onion *i.e.* 30 days after transplanting (at thermo phase), 60 days after transplanting (at competition phase) and 90 days after transplanting (at completion phase).

The data were recorded on ten randomly selected plants from each replication for bulb yield (kg/plot), total bulb yield (q/ha), marketable bulb yield (q/ha), unmarketable bulb yield (q/ha) and economics of various treatments. Harvesting was done when the bulbs were fully developed, leaves started turning yellowish and 50% of the plants showed neck fall. Bulbs harvested from the each experimental plot were weighted and yield per 4.5 m^2 was calculated. The results were later on magnified for 10,000 m^2, keep 30% area out for channels and bunds. Bulbs were graded in five grades based on diameter *viz.*, A$^+$ (>6.5cm), A (5.5-6.5cm), B (4.5-5.5cm), C (3.5-4.5cm) and D (<3.5cm). Marketable bulbs of all grades except diseased, damaged and D grade bulbs from each experimental plot were weighed to calculate marketable yield (q/ha). To calculate the expenditure incurred in the experiment, cost of cultivation of the crop along with treatment cost was first calculated. B: C ratio in each treatment was calculated by dividing the net income with its corresponding gross income. The recorded data were averaged and statistically analysed as per Steel and Torrie (1981) using the statistical programme developed by O.P. Sheoran.

Results and Discussion

The effect of three seedling ages and exogenous application of different growth retardants was studied to understand the yield and economics of onion. The results obtained are presented in Table 1, 2 and 3 for individual effect, interaction and economics of onion cultivation, respectively.

Table 1: Effect of different age of seedling and plant hormones on yield of onion

Treatment	Bulb yield (kg/plot)	Total bulb yield (q/ha)	Marketable yield (q/ha)	Unmarketable yield (q/ha)
Age of seedling				
A$_1$ (6 week old seedling)	3.15	70.06	51.70	18.36
A$_2$ (8 week old seedling)	9.54	212.06	205.40	6.67
A$_3$ (10 week old seedling)	7.74	171.95	156.61	15.89
SEm$\pm$	0.39	8.62	3.25	0.63
CD (p=0.05)	1.11	24.63	9.29	1.81
Plant hormones (ppm)				
C$_1$ (Cycocel 500ppm)	6.03	134.09	117.70	16.40
C$_2$ (Cycocel 1000ppm)	7.48	166.18	148.50	17.70
E$_1$ (Ethephon 2000ppm)	5.82	129.38	114.47	14.93
E$_2$ (Ethephon 2500ppm)	5.30	117.77	103.47	14.27
P$_1$ (Paclobutrazol 1000ppm)	7.59	168.64	158.90	9.73
P$_2$ (Paclobutrazol 2000ppm)	8.57	190.78	181.83	8.53
C$_0$ (Distilled water spray)	6.67	153.08	140.47	13.20
SEm$\pm$	0.59	13.16	4.96	0.97
CD (p=0.05)	1.69	37.62	14.19	2.77

Table 2: Interaction effect between seedling age and plant hormones on yield of onion

Interaction	Bulb yield (kg/plot)	Total bulb yield (q/ha)	Marketable yield (q/ha)	Unmarketable yield (q/ha)
A$_1$ (6 week old seedling)				
C$_1$ (Cycocel 500ppm)	2.77	61.50	40.40	21.10
C$_2$ (Cycocel 1000ppm)	3.57	79.27	57.00	22.30
E$_1$ (Ethephon 2000ppm)	3.07	68.17	48.10	20.10
E$_2$ (Ethephon 2500ppm)	2.50	55.53	36.00	19.50
P$_1$ (Paclobutrazol 1000ppm)	2.97	65.93	51.70	14.20
P$_2$ (Paclobutrazol 2000ppm)	3.70	82.23	69.40	12.80
C$_0$ (Distilled water spray)	3.50	77.77	59.30	18.50
A$_2$ (8 week old seedling)				
C$_1$ (Cycocel 500ppm)	8.30	185.20	177.00	8.20
C$_2$ (Cycocel 1000ppm)	10.43	231.87	222.90	9.00
E$_1$ (Ethephon 2000ppm)	7.60	168.87	161.80	7.10
E$_2$ (Ethephon 2500ppm)	7.40	164.43	157.50	6.90
P$_1$ (Paclobutrazol 1000ppm)	11.10	246.67	241.60	5.10
P$_2$ (Paclobutrazol 2000ppm)	12.77	283.70	279.50	4.20
C$_0$ (Distilled water spray)	9.17	203.70	197.50	6.20
A$_3$ (10 week old seedling)				
C$_1$ (Cycocel 500ppm)	7.00	155.57	135.70	19.90
C$_2$ (Cycocel 1000ppm)	8.43	187.40	165.60	21.80
E$_1$ (Ethephon 2000ppm)	6.80	151.10	133.50	17.60
E$_2$ (Ethephon 2500ppm)	6.00	133.33	116.90	16.40
P$_1$ (Paclobutrazol 1000ppm)	8.70	193.33	183.40	9.90
P$_2$ (Paclobutrazol 2000ppm)	9.23	205.20	196.60	8.60
C$_0$ (Distilled water spray)	8.00	177.77	164.60	14.90
SEm$\pm$	1.03	22.79	8.60	1.68

CD (*p*=0.05)	NS	NS	24.58	NS
CV (%)	26.50	26.10	10.80	21.45

NS=Non-significant

Table 3: Influence of various treatments on economics of onion cultivation

Treatments	Cost of cultivation including treatment cost (₹)	Total bulb yield (q/ha)	Gross Income (₹)	Net Income	B:C ratio
A_1C_1	80,697	61.50	92,250	11,553	0.1
A_1C_2	83,097	79.27	1,18,905	35,808	0.4
A_1E_1	81,417	68.17	1,02,255	20,838	0.3
A_1E_2	82,197	55.53	83,295	1,098	0.01
A_1P_1	78,489	65.93	98,895	20,406	0.3
A_1P_2	78,681	82.23	1,23,345	44,664	0.6
A_1C_0	78,297	77.77	1,16,655	38,358	0.5
A_2C_1	80,697	185.20	2,77,800	1,97,103	2.4
A_2C_2	83,097	231.87	3,47,805	2,64,708	3.2
A_2E_1	81,417	168.87	2,53,305	1,71,888	2.1
A_2E_2	82,197	164.43	2,46,645	1,64,448	2.0
A_2P_1	78,489	246.67	3,70,005	2,91,516	3.7
A_2P_2	78,681	283.70	4,25,550	3,46,869	4.4
A_2C_0	78,297	203.70	3,05,550	2,27,253	2.9
A_3C_1	80,697	155.57	2,33,355	1,52,658	1.9
A_3C_2	83,097	187.40	2,81,100	1,98,003	2.4
A_3E_1	81,417	151.10	2,26,650	1,45,233	1.8
A_3E_2	82,197	133.33	1,99,995	1,17,798	1.4
A_3P_1	78,489	193.33	2,89,995	2,11,506	2.7
A_3P_2	78,681	205.20	3,07,800	2,29,119	2.9
A_3C_0	78,297	177.77	2,66,655	1,88,358	2.4

A_1=6 week old seedling, A_2=8 week old seedling, A_3=10 week old seedling.
C_1=Cycocel 500ppm, C_2=Cycocel 1000ppm, E_1=Ethephon 2000ppm, E_2=Ethephon 2500ppm,
P_1=Paclobutrazol 1000ppm, P_2=Paclobutrazol 2000ppm, C_0=Control (Distilled water spray).

Effect of seedling age
Among three ages of seedlings studied, varied differences in all the yield traits were found to be statistically significant (Table 1). Among the seedling age; maximum bulb yield per plot was recorded in 8 week old seedlings (9.54 kg) which was statistically superior to 10 (7.74 kg) and 6 week old seedlings (3.15 kg), respectively. The considerably higher total bulb yield and marketable yield was obtained from 8 week old seedling (212.06 and 205.40 q/ha) as compared to 10 (171.95 and 156.61 q/ha) and 6 week old seedlings (70.06 and 51.60 q/ha). Similarly, the minimum un-marketable bulb yield (6.67q/ha) was recorded in 8 week old seedlings and maximum unmarketable yield was recorded in 6 week old seedlings (18.36q/ha). The reason might be the optimum age of the seedlings on which bulbing in onion commenced. Similar effects of seedling age on yield characters have been reported by Bhonde *et al.* (2001) [4].
In 8 week old seedling, maximum benefit cost ratio (4.40) was obtained as compared to 10 and 6 week old seedling. The reason for good returns could be attributed to maximum yield of bulbs of this age of seedling. The better results in terms of net returns and benefit cost ratio in 8 week old transplants as reported by Bhonde *et al.* (2001) [4] confirmed the present finding.

Effect of plant hormones
The exogenous application of different plant hormones had significant effect on yield attributes on onion (Table 2). The application of paclobutrazol 2000 ppm significantly increased per plot (8.57 kg/plot) and total bulb yield (190.78q/ha), which was significantly superior to other hormonal treatments and control. Other treatments of hormones showed negative impact on total yield in comparison to control but were statistically non-significant. The statistically higher marketable bulb yield (181.83q/ha) was recorded in the

paclobutrazol treatment @ 2000 ppm than rest of the treatments and control but it was statistically comparable with paclobutrazol @ 1000ppm. Minimum unmarketable bulb yield (8.53 q/ha) was recorded in the higher concentration of paclobutrazol which was statistically lower than rest of the treatments but at par with paclobutrazol @ 1000ppm. The reduction in yield attributes was might be due to inhibition of plant height, production of less number of leaves that might have resulted in low carbohydrate synthesis by the plant and subsequently reduced yield (Hye *et al.,* 2002) [6]. The results are in agreement with the findings of Natlob and El-Habar (1983) [8].

Interactive effect
Interaction of seedling age and plant hormones at different concentrations had significant effect on marketable yield but non-significant results on bulb yield per plot, total bulb yield and unmarketable bulb yield of onion (Table 2). Among the different treatment combinations, the maximum marketable bulb yield was recorded by paclobutrazol 1000 and 2000ppm sprayed on 8 week old seedlings (241.60 and 279.50q/ ha), which was statistically higher to rest of the treatment combinations and control. Although, the remaining treatment combination statistically comparable to each other. It is relevant findings that the application of growth retardants reduced yield mostly in 6 week old seedlings as compared to control. The profound impact of paclobutrazol on yield parameters was clearly due to the reduction in scape formation of the plants leading to bolting in later stages. Such responses of the crop directly influence yield and yield attributed traits (Arvin and Banakar, 2002; Soo *et al.,* 2002) [2, 9].
The application of different plant hormones and three ages of seedlings had significant effect on economics of onion cultivation (Table 3). Application of growth retardants could

not improve yield but increased cost of cultivation as compared to control. In 8 week old seedling, higher benefit cost ratio (4.40) and net returns (₹ 3, 46, 869) were obtained with application of paclobutrazol @ 2000 ppm. The results are in agreement with the findings of Bhonde *et al.* (2001) [4].

References

1. Anonymous. Area and production of onion in India. Indian Horticulture Database, NHB, Ministry of Agriculture, GOI, Gurgaon, Haryana, 2014, 301.
2. Arvin MJ, Banakar MH. Effects of plant growth regulators on bolting and several traits of onion (Allium cepa L.) cv. Texas Early Grano. Journal of Science and Technology of Agriculture and Natural Resources. 2002; 6(1):59-70.
3. Ashraf M, Akram NA, Arteca RN, Foolad MR. The physiological, biochemical and molecular roles of brassinosteroids and salicylic acid in plant processes and salt tolerance. Critical Reviews in Plant Sciences. 2010; 29(3):162-190.
4. Bhonde SR, Chougule AB, Singh NB. Studies on the effect of age of seedlings and date of harvesting on yield and quality of onion during late kharif season. National Horticultural Research and Development Foundation. 2001; 21(1):27-30.
5. Brewster JL. Effects of photoperiod, nitrogen nutrition and temperature on inflorescence initiation and development in onion (*Allium cepa* L.). Annals of Botany. 1983; 51:429-440.
6. Hye AMD, Haque SMD, Karim AMD. Influence of growth regulators and their time of application on yield of onion. Pakistan Journal of Biological Sciences. 2002; 5(10):1021-1023.
7. Levy D, Ventura J, Kedar N. Effect of ethephon on seed stalks growth and seed yield of onion. *Hort Science.* 1972; 7:470-471.
8. Natlob AN, El-Habar MT. The effect of ethrel and maleic hydrazide on bolting and yield of onion cv. Baasheka. Iraqi Journal of Agricultural Science. 1983; 1(1):43-49.
9. Soo LJ, An SY, Cheol SK, Cheol UY, Chun RB. Effect of plug cell size, seedling age, standing number and transplanted depth in a level low on the growth and yield of Welsh onion (*Allium fistulosum* L.). Korean Journal of Horticultural Science and Technology. 2002; 20(4):297-301.
10. Steel GD, Torrie JH. Principle and Procedure of Statistics: A Biochemical Approach. Auckland, Mc-Grawhill, 1981, 32-36.
11. Steer BT. The bulbing response to day length and temperature of some Australasian cultivars of onion (*Allium cepa* L.). Australian Journal of Agricultural Research. 1980; 31:511-518.