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Effect of Transplanting Dates and PGRs on Growth and Yield of *Kharif* Onion (*Allium cepa* L.) under Bihar Region

Neha Kumari Singh[1*], R. B. Verma[1], Vijay Kumar[2] and Randhir Kumar[3]

Department of Horticulture (Vegetable and Floriculture), BAC, Bihar Agricultural University, Sabour, Bhagalpur, India-813210

**Corresponding author*

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A B S T R A C T

An experiment was conducted at Vegetable Research farm, Bihar Agricultural University, Sabour, Bhagalpur, Bihar during2018 to explore the possibility of growing *Kharif* onion inBihar region for higher yield and economic return. A short day variety (Agrifound Dark Red) of Kharif onion was transplanted in three dates (21st July, 6th August and 22nd August) with seven PGRs concentrations (control (water spray), Ethephon 2000ppm,2500 and 3000ppm) and Cycocel (1500ppm2000and 2500ppm) in split- plot design with three replications. Observations were recorded on plant height and number of leaves per plant at 60 and 90 DAT, polar and equatorial diameter, average and marketable bulb yield. Economics of the various treatments was also calculated to study the most profitable treatment combinations. The experimental results revealed that the transplanting on22 August produced maximum plant height(63.01cm)and number of leaves (10.13) at 90 DAT, polar diameter(4.72cm), equatorial diameter(5.47cm), average bulb yield(86.49g) and marketable yield(321.63q/ha).Among PGRs, Cycocel 1500ppm resulted into higher equatorial diameter(5.37cm), average bulb weight (81.94g) and yield (281.34q/ha). So far as the economics is concerned the transplanting *kharif* onion on 22 August and spray of cycocel 1500ppm was found to be most economically viable as it produced the highest bulb yield and incurred maximum B: C ratio (2.69).

Introduction

Onion is an important commercial bulb crop which earns foreign exchange more than the other vegetables.India is the second largest producer of onion with an area of 1.29 million ha, production of 23.26 million tons and the productivity of 18.10t/ha after china in world (NHB, 2018). Maharashtra is the leading state in onion production. However, the area covered by Bihar under onion cultivation is 0.06 million ha with production of 1.26 million tons and productivity 23.09t/ha.

In Maharashtra, onion is grown as *Kharif, late Kharif* and *Rabi crops* (Gorrepati *et al.*, 2018), while in Bihar, it is mainly grown as *Rabi*

crop during October - November *which accounts 60 per cent of onion production. Growing of Kharif* season onion isnot in vogue but taken in small pockets in Bihar during June – July, which accounts only about 20 per cent of total onion production in Bihar due to unawareness of *Kharif* onion among the farmers. Its cultivation is a new strategy in northern, eastern and central India to meet the demands of fresh bulbs in off season and regularize to normal price by covering the gap during peak periods. The transplanting of *kharif* onion in Bihar is started from the onset of monsoon but the appropriate date has not been standardized so for. Plant growth regulators are considered as a new generation of agrichemicals that modify the growth of plant usually by stimulating one part of the natural growth regulatory system, thereby enhances yield. Ethephon being a ripening hormone, induces uniform ripening and leaf senescence while, cycocel is a growth retardant and shows anti gibberellin action which negates the endogenous effect of GA and increases yield (Chaudhary and Kumar,2015). Keeping these facts in to consideration an experiment.

Materials and Methods

An experiment was planned and performed during *kharif* season 2018-19 at vegetable research farm, Department of Horticulture (Vegetable and Floriculture), BAU, Sabour to study the Effect of transplanting dates and PGRs on growth and Yield of *kharif* onion. The geographical location of Bhagalpur comes under the Middle Gangetic plain region of Agro-climate Zone III Ain Bihar state under heart of vast Indo-Gangetic plains of India. It lies between latitude of 25˚ 24'N and longitude 87˚05'E with an altitude of 52.73 meters above the mean sea level. Twenty one treatment combinations comprising of three dates of transplanting (D_1: 21July, D_2: 6 August and D_3: 22 August) and seven treatments of foliar applications of PGRs (control: water spray, E_1: Ethephon @ 2000ppm, E2: Ethephon @ 2500ppm, E_3: Ethephon @ 3000ppm, C1:Cycocel @1500ppm, C_2:Cycocel @2000ppm and C_2:Cycocel @2500ppm) were arranged in split-plot design with three replications. A short day variety Agrifound Dark Red was used for the experimentation. Six week old seedlings were transplanted as per scheduled date and PGRs were sprayed at 90 days after transplanting. Only water was used for the spray in control plots. All the recommended package of practices was followed for the healthy crop. The observations were recorded on plant height, number of leaves, neck thickness, polar diameter, equatorial diameter, average bulb weight and marketable yield.

Plant height and number of leaves per plant were recorded at 60 and 90 days after transplanting (DAT)with help of meter scale from base to the longest tip of the leaf and counting manually, respectively. Neck thickness of five randomly selected bulbs in each treatment was measured with the help of digital vernier calipers (mm) at narrowest part 5mm above to the top of each bulb and their average was calculated. Polar and equatorial diameter was measured using vernier calipers from base of neck to the bottom of bulb in vertically and by horizontal placement of onion bulb parallel to the ground, respectively and expressed in centimeter. Average bulb weight (g) were taken by weighing the five tagged bulbs with the help of electronic balance and dividing them by 5 and expressed in gram while, total and marketable yield was calculated on per plot basis in kilogram and finally converted in to quintal per hectare. Marketable yield was recorded after the exclusion of damaged and diseased bulbs. Economics of the treatment was also calculated by adding the costs of all the input used during experimentation. Gross income was calculated by multiplying the total yield

by the rate prevailing during crop season. Net return was measured by subtracting the total cost of cultivation from gross income while, B: C ratio was calculated by dividing the net return by total cost of cultivation. Data collected on account of various growth and yield attributing traits were subjected for statistical analysis following the standard procedure of Cochran and Cox (1970). Critical difference was also calculated to draw the valid conclusion.

Results and Discussion

Effect of transplanting dates on growth and yield parameters and bulb yield of *Kharif* onion

The Data regarding various growth and yield parameters and yield as influenced by dates of transplanting and, PGRs and their interactions have been presented in Table 1 and Table 2. Results revealed that the dates of transplanting, PGRs and their interactions had significant effect on plant height and number of leaves per plant at 60 and 90DAT respectively, polar and equatorial diameter of bulb, average weight of bulb and marketable bulb yield of *Kharif* onion. The yield of *Kharif* onion depends on all the crop growth stages, thus determination of optimum time is an important factor. For its production environmental condition, temperature, relative humidity and day length also play an important role in all the crop growth stages especially the plant height. The result of the present study indicated that time f transplanting f *Kharif* onion had a significant effect on plant height and number of leaves per plant at 60 and 90 days after transplanting (Table 1). Transplanting of *Kharif* onion on 6th August (D_3) produced the tallest plant (45.06 and 67.01cm) and more number of leaves per plant (6.49 and 10.13) at60 and 90 DAT, respectively. The progressive increase in the parameters under D_3(22 August) transplanting date might be due to congenial environment for better and early establishment of seedling in the field by exhibiting minor transplanting shock as compared to other transplanting dates,which might have helped the plants to induce more height with greater surface area for producing more number of leaf primordial and young leaves during the growing season. These findings get full support by findings of Ibrahim and Latif *et al.,* (2010).

Neerja *et al.,* (2000) and Singh (1993) also advocated the role of transplanting dates on growth and yield of onion. Mehri *et al.,* (2015) and Mohanty *et al.,* (2000) reported the progressive increase in vegetative growth with increase in the temperature during July-August.

Yield is mainly depends on the growth parameters as well as yield attributing traits. Table 1 clearly indicated that that the polar and equatorial diameter of bulb, average weight of bulb and yield of marketable bulb had varied significantly due to transplanting of *Kharif* onion on various dates and produced the bulb of the maximum polar (4.72cm) and equatorial (4.47cm) diameter, average weight (86.49g) of bulb and yield (321.63q/ha) of marketable bulb when transplanted on 22ndof August (D_3) as compared to other dates of transplanting (21Julyand 6 August).

The progressive increase in yield attributing parameters due to advancing transplanting time up to D_3 (22nd August) might be due to the increased in growth parameters like higher plant height and more number of leaves per plant, which might have resulted into synthesis and translocation of more carbohydrate and ultimately increased the polar diameter, equatorial diameter and average weight of bulb. The present findings are in close conformity with the findings of Hye *et al.,* (2002) and Gautam *et al.,* (2006).
Marketable yield is the resultant of yield

contributing traits, which was found significantly higher (321.63q/ha) in D_3 (22nd August) transplanting date than both of the early planting dates. Minimum yield (205.79q/ha) was recorded under D_1 (21st July) transplanting date. The progressive increase with the delay in transplanting of *Kharif* onion on D_3 (22August) as compared to D_2 (6August) and D_1(21 July)might be due to the fact that the transplanting of *Kharif* onion on 22nd August received the favourable climatic conditions like temperature and day length, field situation and less transplanting socks, which increased the growth as well as yield attributing traits like polar and equatorial diameter and average weight of bulb and ultimately the yield of bulb. The results get full support with the findings of Gautam *et al.*, (2006).

Table.1 Effect of transplanting dates and PGRs yield of *Kharif* onion (*Allium cepa* L.) under Bihar region

Treatment	Plant height		No. of leaves		Neck thickness (mm)	diameter of bulb (cm)		Av. Bulb yield (g)	Marketable yield (q/ha)
	(60 DAT)	(90 DAT)	(60 DAT)	(90 DAT)		Polar	Equatorial		
Dates of Transplanting									
D1(21July)	42.72	60.29	6.34	9.86	10.49	3.49	3.90	62.42	205.79
D2(6 Aug)	43.32	60.36	6.31	9.95	10.52	4.69	5.25	83.67	268.03
D3(22Aug)	45.60	63.01	6.49	10.13	10.66	4.72	5.47	86.49	321.63
SEm±	0.44	0.30	0.03	0.03	0.08	0.03	0.04	0.43	2.54
C.D.(0.05)	1.75	1.16	0.12	0.14	0.33	0.12	0.16	1.68	9.98
PGRs									
Control	44.93	62.19	6.60	9.94	10.73	4.47	4.96	77.11	266.30
E1(2000ppm)	43.15	61.58	6.33	9.71	10.69	4.20	4.89	79.47	263.74
E2(2500ppm)	44.31	60.56	6.42	10.08	10.59	4.33	4.61	73.41	258.73
E3(3000ppm)	43.45	61.76	6.24	10.01	10.52	4.29	4.42	71.08	244.60
C1(1500ppm	43.19	60.48	6.65	10.25	10.68	4.37	5.37	81.94	281.34
C2(2000ppm)	44.52	60.26	6.23	9.99	10.35	4.35	5.13	80.58	276.03
C3(2500ppm)	43.60	61.70	6.19	9.87	10.34	4.12	4.75	80.11	265.32
SEm±	0.61	0.85	0.15	0.20	0.19	0.08	0.09	1.19	2.55
C.D.(0.05)	1.75	2.44	0.43	0.58	0.54	0.22	0.25	3.42	7.32

Table.2 Interaction due to dates of transplanting and PGRs

Treatment	Plant height(cm)		No. of leaves		Neck thickness (cm)	diameter of bulb(cm)		Average bulb yield (g)	Marketable yield (q/ha)
	60 DAT	90 DAT	60 DAT	90 DAT		Polar	Equatorial		
D1C0	44.06	61.01	6.49	9.97	10.78	3.46	4.25	57.23	218.09
D1E1	41.23	59.06	5.78	9.70	10.50	3.32	3.93	65.05	212.00
D1E2	45.77	60.36	6.14	9.99	10.10	3.38	3.23	60.16	190.78
D1E3	42.63	61.40	6.18	9.91	10.66	3.43	3.52	58.22	177.25
D1C1	40.18	60.05	7.30	9.80	10.30	3.68	4.25	66.84	219.98
D1C2	44.36	60.90	6.19	9.90	10.24	3.67	4.16	64.46	212.08
D1C3	40.80	59.24	6.29	9.74	10.83	3.49	3.97	65.00	210.34
D2C0	40.72	59.69	6.52	9.67	10.33	5.24	5.11	86.89	270.72
D2E1	44.60	62.27	6.60	9.13	11.21	4.37	4.88	83.90	264.92
D2E2	41.87	58.85	6.43	10.09	10.82	4.81	5.21	77.47	264.43
D2E3	43.17	63.26	5.83	10.06	10.27	4.54	4.39	73.57	247.18
D2C1	44.69	59.37	6.27	10.80	10.42	4.82	6.20	88.41	272.70
D2C2	43.92	60.27	6.25	9.92	10.51	4.83	5.70	88.15	284.92
D2C3	44.25	58.80	6.28	10.00	10.08	4.26	5.27	87.30	271.34
D3C0	50.00	65.86	6.80	10.20	11.06	4.71	5.51	87.22	310.09
D3E1	43.63	63.39	6.60	10.29	10.37	4.90	5.84	86.45	314.29
D3E2	45.29	62.48	6.70	10.16	10.85	4.79	5.39	82.59	320.97
D3E3	44.53	60.63	6.72	10.06	10.64	4.89	5.34	81.46	309.37
D3C1	44.72	62.03	6.37	10.17	11.31	4.60	5.65	90.57	351.33
D3C2	45.29	59.63	6.25	10.14	10.31	4.56	5.54	89.13	331.09
D3C3	45.77	67.07	6.00	9.88	10.09	4.61	5.00	88.03	314.29
SEm±	1.06	1.48	0.26	0.35	0.33	0.13	0.15	2.07	4.42
C.D.(P=0.05)	3.04	4.23	0.75	1.01	0.93	0.37	0.43	5.92	12.68

Table.3 Economics of treatments

Treatment	Yield(q/ha)	Total cost of cultivation (Rs./ha)	Gross Income(Rs/ha)	Net Income (Rs/ha)	B:C Ratio
D1C0	218.09	61411.00	218090.00	156679.00	2.55
D1E1	212.00	62847.16	212000.00	149152.80	2.37
D1E2	190.78	63185.08	190780.00	127594.90	2.02
D1E3	177.25	63565.24	177250.00	113684.70	1.79
D1C1	219.98	62611.00	219980.00	157369.00	2.51
D1C2	212.08	63011.00	212080.00	149069.00	2.37
D1C3	210.34	63411.00	210340.00	146929.00	2.32
D2C0	270.72	61411.00	270720.00	209309.00	3.41
D2E1	264.92	62847.16	264920.00	202072.80	3.22
D2E2	264.43	63185.08	264430.00	201245.00	3.19
D2E3	247.18	63565.24	247180.00	183614.80	2.89
D2C1	272.70	62611.00	272700.00	210089.00	3.36
D2C2	284.92	63011.00	284920.00	221909.00	3.52
D2C3	271.34	63411.00	271340.00	207929.00	3.28
D3C0	310.09	61411.00	310090.00	248679.00	4.05
D3E1	314.29	62847.16	314290.00	251442.80	4.00
D3E2	320.97	63185.08	320970.00	257785.00	4.08
D3E3	309.37	63565.24	309370.00	245804.00	3.87
D3C1	351.33	62611.00	351330.00	288719.00	**4.61**
D3C2	331.09	63011.00	331090.00	268079.00	4.25
D3C3	314.29	63411.00	314290.00	250879.00	3.96

Effect of plant growth regulators on growth and yield parameters and bulb yield of *Kharif* onion

Ethephon is a systemic plant growth regulator of phosphonate family. It is readily absorbed by plants and releases ethylene, which influences many plant physiological processes directly like ripening, maturation etc. and stimulates endogenous production (www.fao.org> Evaluation 94 –JMPR, 1977).

Ethephon also reported to reduce sprouting losses. (Anbukarasi, *et al.,* 2013). Cycocel is an important plant growth retardant used to induce dwarfism in plants as results into shorter internodes, stronger stems and green leaves.

The response of CCC (chloremaquat) can vary depending on doses or concentrations, site of application, cultivars and also growing season (Taiz and Zeiger, 2006). It slows down cell division and cell elongation of tissues of stem and regulates plant height physiologically without formative cells. It has anti-gibberellin action on growth that supplies photosynthates to reproductive growth for increasing yield.

In present investigation, none of the concentration showed significant improvement for all the growth parameters like plant height and number of leaves at 60 and 90 days after transplanting and neck thickness at the time of harvesting after curing.

Insignificant effect was only due to the fact that the various concentrations of plant growth regulators were applied after 90 DAT. However, it showed a significant effect on polar and equatorial diameter of bulb. It was observed that the equatorial diameter as well as neck thickness was maximum under C_1 (CCC@ 1500ppm), while polar diameter was minimum at C_3 (CCC@2500ppm).

The progressive increase in equatorial diameter and neck thickness might be due to the anti-gibberellin action of cycocel which might have reduced the vegetative growth and promoted reproductive growth. It also might have diverted the photosynthates from vegetative phase to the reproductive phase and ultimately accumulated more dry matter horizontally into the bulbs. Similar effects of growth retardants have also been studied by Shaikh *et al.,* (2002), Ashrafunzzaman *et al.,* (2009) and Vishal *et al.,* (2016).

Significantly maximum increase in average bulb weight (81.94g) as well as marketable yield (281.34 q/ha) was associated with the foliar application of Cycocel @1500ppm This increase in yield might be due to the fact that the CCC had the anti-gibberellin action and diverted the carbohydrate supply to reproductive phase which ultimately resulted into greater bulb size and weight of bulb. Similar findings have also been made by Vishal *et al.,* (2017)

Interaction effect of date of transplanting and plant growth regulators on growth and yield parameters and bulb yield of *Kharif* onion

The interactions due to dates of transplanting and PGRs showed pronounced effect on growth and yield parameters and yield of onion. The combination of D_3 × control increased the plant height and number of leaves at 60 and 90 DAT except number of leaves at 90 DAT which was maximum (10.80)when the seedlings were transplanted on 2 August and the standing crop was sprayed with the Cycocel @ 1500ppm (D_2 × C_1). This increase might be due to increased sink capacity (Mohanty *et al.,* 2000). Transplanting on D_3 (22^{nd} August) might have exhibited minor transplanting shock as compared to other transplanting dates and resulted into better establishment in the field that helped the plants to induce more height with greater surface area for producing more number of young leaves during the growing season. These findings get full support by Ibrahim,2010; Latif *et al.,* (2010), Jones *et al.,* (2009) and Choudhary *et al.,* (2016). Dates of transplanting and application of PGRs interacted significantly and produced maximum polar diameter under treatment combination D_2 × Control (5.4cm) and minimum polar diameter was noticed under treatment combination of D_1 ×E_1 (3.32cm). The results are in close conformity with the results of Gautam *et al.,* (2006). Transplanting of seedling of onion on 6 August and spray of crp with cycocel @ 1500ppm (D_2 × C_1) had maximum (6.20cm) equatorial diameter. It may probably be due to the fact that the cycocel had the anti-gibberellin action, which might have reduced vegetative growth and promoted the supply of photosynthates to the reproductive phase and ultimately accumulated more dry matter horizontally in bulbs. Minimum polar and equatorial diameter was found in D_1 × E_1 and D_1 × E_2, respectively, which may be due to the fact that the ethephon might have promoted senescence at early and failed to divert the dry matter accumulation towards bulb. Similar effects of growth retardants have also been studied by Shaikh *et al.,* (2002); Ashrafunzzaman *et al.,* (2009), (Vishal *et al.,* 2016) and choudhary *et al.,* (2016).

Marketable yield found significantly higher (351.33q/ha) under treatment combination of

$D_3 \times C_1$ as compared to other treatment combinations (Table 2. The progressive improvement in marketable yield of bulb under$D_3 \times C_1$ may be due to the fact that the transplanting on 22ndAugust with foliar spray of cycocel @1500ppm might have showed the anti-gibberellin action provided favourable environment for growth and yield attributing traits that ultimately increased the marketable bulb yield This result gets full support by Gautam *et al.,* (2006) and Vishal *et al.,* (2017).

Economic feasibility of various treatments

Economic feasibility of various treatments was analyzed and enframmed in Table 3. It was observed that the transplanting of *Kharif* onion on 22 August and spray of Cycocel with 1500ppm (D_3C_1) yielded maximum and incurred the highest B: C ratio(4.61)

From the above findings it can be inferred that the transplanting of *Kharif* onion on 22 August and spray of crop with Cycocel @ 1500ppm at 15 days prior to harvesting is economically feasible and profitable for onion grower, however, the confirmation of results is required by conducting one year trial more.

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