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Effect of Different Plant Growth Regulators, Micronutrients and Photothermal Regimes on Growth, Phenological and Yield Characters of Brinjal (*Solanum melongena* L.)

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A B S T R A C T

An investigation entitled "Effect of different plant growth regulators, micronutrients and photothermal regimes on morphological and phenological characters of Brinjal (*Solanum melongena* L.)" was conducted at Horticulture Complex, Department of Horticulture, College of Agriculture JNKVV, Jabalpur (M.P.) during the year 2018-19. The experiment consists of forty five treatments comprising plant growth regulators, micronutrients and different photothermal regimes and was laid out in randomized block design having three replications. There were two plant growth regulators Brassinosteroids (0.5µM, 1.0µM), GA_3 (25 ppm, 50 ppm) and two micronutrients Boron (100 ppm), Molybdenum (2.0µmol/l) were use with different combinations and were applied by foliar application on 15^{th} November, 30^{th} November and 15^{th} December to assess the effect on growth and yield of brinjal. The investigation revealed that, the vegetative growth observations (plant height of plant at 30, 60 and 90 DAT, number of primary branches per plant and number of flower per cluster), phenological observations (viz. minimum days to flower initiation, days to 50% flowering, days to first picking) and yield per plot was reported in treatment where plant has been sprayed with T_9 (GA_3 (50ppm) + Boron (100ppm) whereas the control was lowest.

Introduction

Brinjal (*Solanum melongena* L.) also known as eggplant in USA and aubergine in France and UK is a member of angiospermic family Solanaceae. It is known as King of Vegetables. It is a popular vegetable crop widely grown in tropics and subtropics (Roychowdhury and Tah, 2011). According to Vavilov (1928), the eggplant originated in Indo-Burma region. India is the primary centre of origin (Zeven and Zhukovsky, 1975) while secondary diversity in China and South East Asia (Nath *et al.*, 1987).

India is the second largest producer of brinjal in the world**.** Area under brinjal in India is 730 thousand hectare with production of 12801 thousand metric tonnes and productivity is 17.5 metric tonnes/ hectare. It is grown in 51.35 thousand hectare area in Madhya Pradesh with a total annual production of 1073.63 thousand metric tonnes with 20.19 metric tonnes/hectare productivity (National Horticulture Board, 2018). Brinjal contains 92.7 per cent water, 4 percent carbohydrates, 1.4 per cent protein, 1.3 per cent fiber, 0.3 per cent fats, 0.3 per cent minerals and vitamin A in a negligible quantity (Tindall, 1978) and it is also a rich source of minerals like potassium, calcium, sodium and iron (Mohamed *et al.*, 2003; Raigon *et al.*, 2008) as well as dietary fibre (USDA, 2014; Sanchez-Castillo *et al.*, 1999). Brinjal is an annual herbaceous plant. Inflorescence is often solitary but sometimes it constitutes a cluster of 2-5 flowers. Flower is complete, actinomorphic and hermaphrodite. Only long and medium styled flowers are considered as fruit setting flowers. Further, possibilities of cross pollination are more in long style flowers. Fruit setting of long styled flowers ranges from 70% to 86.7% in different varieties. In medium styled flowers, fruit set varies from 12.5% to 55.6%.

Climate change results in crop failures, reduction in yield and quality and increasing pest and disease problems which renders the vegetable cultivation unprofitable. Brinjal is a warm season crop and susceptible to severe frost. Climatic conditions, especially low temperature during cool season cause abnormal development of the ovary (splitting) in flower buds which then differentiate and develop into deformed fruits during that season (Nothmann and koller, 1973). Cool nights and short summers are unfavorable to its satisfactory yield. The reduction in the yield of brinjal is due to to its poor physiological efficiency, poor fruit setting and non- synchronize maturity.

Application of plant growth regulators (PGRs) may play an important role in proper flowering, fruit setting, synchronize maturity, ripening and thereby increase the yield of the crops. Gibberellin promotes shoot growth by accelerating the cell elongation and also increases plant height, number of branches per plant, size of leaves and fruits. (Dhakar and Singh, 2015) and significantly reduces the number of seeds per fruit. Brassinosteroids (BRs) are a novel group of phyto- hormones occurring in plant steroid hormones and are distributed throughout the plant kingdom (Krishna, 2003; Montoya *et al.*, 2005). Brassinosteroids plays prominent roles in various physiologic processes, like cell elongation, pollen tube growth, root inhibition, ethylene biosynthesis, senescence, photosynthesis, and enzyme activation (Sasse 2003, Bajguz and Hayat 2009, Hayat *et al.*, 2012) and it is also have ameliorative effect on plants subjected to environmental stress such as cold stress (Liu *et al.*, 2009), heat stress (Ogweno *et al.*, 2008), oxidative damage (Cao *et al.*, 2005) and pathogen infection (Nakashita *et al.*, 2003; Zhou *et al.*, 2004). It is also observed that application of micronutrients plays a role in improving the yield and quality of brinjal. Boron changes the chemical composition, structure of cell walls, and phenol metabolism and has prominent role in sugar transport, impairment of plasma membrane and phyto hormone metabolism. Molybdenum (Mo) is an essential trace element for plant growth, development and production (Sabatino *et al.*, 2019). It is required for the formation of the nitrate reductase enzyme and has a striking effect on pollen formation (Siddiky *et al.*, 2007). Stress resistance in Molybdenum deficient plants is decreased against low temperature.

Materials and Methods

The experiment was conducted at Horticulture complex, Department of Horticulture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (M.P.) during the year 2018-19. The soil of the experimental field was medium black and good drainage uniform texture. The experiment was laid out in Randomized Complete Block Design (RCBD- factorial) with three replications. The field experiment consisted of 45 treatments involving the combination of plant growth regulators, micronutrients and different photothermal regimes. Plant growth regulators applied were Brassinosteroids (0.5 µM, 1.0 µM) and GA_3 (25 ppm, 50 ppm)and micronutrients applied were boron (100 ppm) and molybdenum (2.0µmol/l)as foliar spray at pre flowering and post flowering stages of plant on three different date of transplanting (15^{th} November, 30^{th} November and 15^{th} December). The observations were recorded in each plot from randomly selected five tagged plant. The recorded observations were plant height at 30, 60, 90 DAT (days after transplanting), number of primary branches per plant, number of flower per cluster, days to flower initiation, days to 50% flowering, days to first picking and yield (kg/plot) (Table 1).

Results and Discussion

Plant height at 30, 60 and 90 DAT

The maximum plant height at 30 DAT was observed in D_1T_9 (47.15) which was transplanted on 15^{th} November with the foliar application of GA_3 (50ppm) + Boron (100ppm) followed by D_1T_8 (46.62) while the minimum plant height at 30 DAT was recorded in control- D_3T_{31} (34.26) which was transplanted on 15^{th} December. The maximum plant height at 60 DAT was recorded in D_1T_9 (61.29) which were transplanted on 15^{th} November with the foliar application of GA_3 (50ppm) + Boron (100ppm) followed by D_2T_{24} (61.19) while the minimum plant height at 60 DAT was recorded in control- D_3T_{31} (41.81). The maximum plant height at 90 DAT was recorded in D_1T_9 (76.93) which were transplanted on 15^{th} November with the foliar application GA_3 (50ppm) + Boron (100ppm) of followed by D_2T_{24} (75.59) while the minimum plant height at 90 DAT was recorded in control- D_3T_{31} (50.16).

The increase in plant height due to the reason that, GA_3 stimulate cell division, cell elongation and cell enlargement and ultimately lead to better plant growth and role of boron in cell wall formation, cell development and elongation. The findings of Kumar *et al.*, (2014), El- Gawad and Osman (2014), Islam (2015), Akand *et al.*, (2016), Chauhan *et al.*, (2017) and Jakhar *et al.*, (2018) were similar to that of the present findings (Table 2).

Table.1 Details of treatment

T_1	**Control**	**T_6**	**Boron (100ppm)**	**T_{11}**	**GA_3 (50ppm)+ Molybdenum (2.0µmol/l)**
T_2	GA_3 (25 ppm)	T_7	Molybdenum (2.0µmol/l)	T_{12}	Brassinosteroids (0.5µM)+Boron (100ppm)
T_3	GA_3 (50 ppm)	T_8	GA_3 (25ppm)+Boron (100ppm)	T_{13}	Brassinosteroids (1.0µM)+Boron(100ppm)
T_4	Brassinosteroids (0.5µM)	T_9	GA_3 (50ppm)+Boron(100ppm)	T_{14}	Brassinosteroids(0.5µM) +Molybdenum (2.0µmol/l)
T_5	Brassinosteroids (1.0µM)	T_{10}	GA_3 (25ppm)+Molybdenum (2.0µmol/l)	T_{15}	Brassinosteroids (1.0µM) +Molybdenum (2.0µmol/l)

1. Three Dates of transplanting at 15 days interval (D_1, D_2 and D_3)
2. Plant growth regulators
3. Micronutrients

Table.2 Effect of various plant growth regulators, micronutrients and photothermal regimes on plant height of brinjal at 30, 60, 90 and 120 DAT

Treat. Symb.	Treatments	Plant height (cm) at		
		30 DAT	60DAT	90DAT
T_1	D1 +Control	36.65	42.88	50.71
T_2	D1 + GA_3 (25 ppm)	42.74	50.51	60.97
T_3	D1 + GA_3 (50 ppm)	43.62	52.37	63.38
T_4	D1 +Brassinosteroids (0.5µM)	42.89	50.35	59.48
T_5	D1 +Brassinosteroids (1.0µM)	43.49	50.97	60.28
T_6	D1 + Boron (100ppm)	42.35	50.64	60.60
T_7	D1 + Molybdenum (2.0µmol/l)	37.38	44.79	53.71
T_8	D1+ GA_3(25ppm)+Boron (100ppm)	46.62	58.81	74.00
T_9	D1+ GA_3(50ppm)+Boron(100ppm)	47.15	61.29	76.93
T_{10}	D1+ GA_3(25ppm)+Molybdenum(2.0µmol/l)	42.06	56.34	70.14
T_{11}	D1 + GA_3 (50ppm)+Molybdenum(2.0µmol/l)	42.17	55.68	68.26
T_{12}	D1 +Brassinosteroids (0.5µM)+Boron(100ppm)	44.34	58.27	71.42
T_{13}	D1 +Brassinosteroids (1.0µM)+Boron(100ppm)	44.36	60.48	72.66
T_{14}	D1 +Brassinosteroids (0.5µM) +Molybdenum(2.0µmol/l)	41.63	53.47	67.09
T_{15}	D1 +Brassinosteroids (1.0µM) +Molybdenum(2.0µmol/l)	41.74	52.98	67.28
T_{16}	D2 +Control	35.92	42.36	51.16
T_{17}	D2 + GA_3 (25 ppm)	41.16	49.11	58.93
T_{18}	D2 + GA_3 (50 ppm)	42.93	51.88	62.00
T_{19}	D2 +Brassinosteroids (0.5µM)	42.23	49.51	57.96
T_{20}	D2 +Brassinosteroids (1.0µM)	43.18	51.41	61.19
T_{21}	D2 + Boron (100ppm)	41.73	50.14	59.57
T_{22}	D2 + Molybdenum (2.0µmol/l)	36.47	43.91	52.36
T_{23}	D2+ GA_3(25ppm)+Boron (100ppm)	45.91	59.22	72.90
T_{24}	D2+ GA_3(50ppm)+Boron(100ppm)	46.68	61.19	75.59
T_{25}	D2+ GA_3(25ppm)+Molybdenum(2.0µmol/l)	43.86	55.45	69.21
T_{26}	D2 + GA_3 (50ppm)+Molybdenum(2.0µmol/l)	41.64	55.07	66.85
T_{27}	D2 +Brassinosteroids (0.5µM)+Boron(100ppm)	42.73	54.66	65.97
T_{28}	D2 +Brassinosteroids(1.0µM)+Boron(100ppm)	43.39	56.07	69.79
T_{29}	D2 +Brassinosteroids(0.5µM) +Molybdenum(2.0µmol/l)	41.59	54.26	67.25
T_{30}	D2+Brassinosteroids(1.0µM) +Molybdenum(2.0µmol/l)	42.04	53.45	66.34
T_{31}	D3+Control	34.26	41.81	50.16
T_{32}	D3 + GA_3 (25 ppm)	40.98	48.70	58.83
T_{33}	D3 + GA_3 (50 ppm)	42.57	52.15	62.00
T_{34}	D3 +Brassinosteroids (0.5µM)	40.73	48.81	58.56
T_{35}	D3 +Brassinosteroids (1.0µM)	41.58	51.22	58.94
T_{36}	D3 + Boron (100ppm)	41.72	50.54	58.88
T_{37}	D3 + Molybdenum (2.0µmol/l)	34.40	44.18	52.71
T_{38}	D3+ GA_3(25ppm)+Boron (100ppm)	45.51	54.51	68.81
T_{39}	D3+ GA_3(50ppm)+Boron(100ppm)	45.76	57.88	73.58
T_{40}	D3+ GA_3(25ppm)+Molybdenum(2.0µmol/l)	44.24	53.89	68.10
T_{41}	D3+ GA_3 (50ppm)+Molybdenum(2.0µmol/l)	44.59	54.52	66.86
T_{42}	D3 +Brassinosteroids (0.5µM)+Boron(100ppm)	43.58	53.30	66.08
T_{43}	D3+Brassinosteroids (1.0µM)+Boron(100ppm)	43.54	54.59	67.87
T_{44}	D3+Brassinosteroids (0.5µM) +Molybdenum(2.0µmol/l)	41.70	51.89	66.04
T_{45}	D3 +Brassinosteroids (1.0µM) +Molybdenum(2.0µmol/l)	42.22	52.85	65.92
	SEm ±	1.24	1.74	2.27
	C.D. at 5% level	3.51	4.91	6.42

Table.3 Effect of various plant growth regulators, micronutrients and photothermal regimes on no. of primary branches, No. of flowers per cluster and days to flower initiation

Treat. Symb.	Treatments	No. of primary branches/ plant	No. of flowers per cluster	Days to flower initiation
T_1	D1 +Control	4.37	3.80	43.57
T_2	D1 + GA_3 (25 ppm)	5.17	4.40	43.09
T_3	D1 + GA_3 (50 ppm)	5.10	4.60	42.08
T_4	D1 +Brassinosteroids (0.5µM)	5.03	4.33	43.28
T_5	D1 +Brassinosteroids (1.0µM)	5.37	4.33	42.31
T_6	D1 + Boron (100ppm)	5.40	4.87	42.71
T_7	D1 + Molybdenum (2.0µmol/l)	5.50	4.13	43.38
T_8	D1+ GA_3(25ppm)+Boron (100ppm)	5.60	4.80	38.32
T_9	D1+ GA_3(50ppm)+Boron(100ppm)	5.67	4.93	37.59
T_{10}	D1+ GA_3(25ppm)+Molybdenum(2.0µmol/l)	5.00	4.33	40.20
T_{11}	D1 + GA_3 (50ppm)+Molybdenum(2.0µmol/l)	4.93	4.20	39.83
T_{12}	D1 +Brassinosteroids (0.5µM)+Boron(100ppm)	5.20	4.73	39.51
T_{13}	D1 +Brassinosteroids(1.0µM)+Boron(100ppm)	4.90	4.60	41.68
T_{14}	D1+Brassinosteroids(0.5µM)+Molybdenum(2.0µmol/l)	4.77	4.20	41.29
T_{15}	D1+Brassinosteroids(1.0µM)+Molybdenum(2.0µmol/l)	4.90	3.93	41.12
T_{16}	D2 +Control	3.97	3.50	45.69
T_{17}	D2 + GA_3 (25 ppm)	4.57	4.10	43.41
T_{18}	D2 + GA_3 (50 ppm)	4.60	4.57	42.43
T_{19}	D2 +Brassinosteroids (0.5µM)	5.00	4.03	45.45
T_{20}	D2 +Brassinosteroids (1.0µM)	4.57	4.07	42.51
T_{21}	D2 + Boron (100ppm)	4.73	4.70	42.74
T_{22}	D2 + Molybdenum (2.0µmol/l)	5.03	3.90	44.24
T_{23}	D2+ GA_3(25ppm)+Boron (100ppm)	5.00	4.57	38.46
T_{24}	D2+ GA_3(50ppm)+Boron(100ppm)	5.57	4.77	37.76
T_{25}	D2+ GA_3(25ppm)+Molybdenum(2.0µmol/l)	4.63	3.73	40.33
T_{26}	D2 + GA_3 (50ppm)+Molybdenum(2.0µmol/l)	4.53	4.27	40.09
T_{27}	D2 +Brassinosteroids (0.5µM)+Boron(100ppm)	5.53	4.57	39.56
T_{28}	D2 +Brassinosteroids(1.0µM)+Boron(100ppm)	4.57	4.57	41.72
T_{29}	D2+Brassinosteroids(0.5µM)+Molybdenum(2.0µmol/l)	5.10	3.97	41.40
T_{30}	D2+Brassinosteroids(1.0µM)+Molybdenum(2.0µmol/l)	4.53	3.70	41.09
T_{31}	D3+Control	3.63	3.23	45.89
T_{32}	D3 + GA_3 (25 ppm)	4.50	3.67	43.65
T_{33}	D3 + GA_3 (50 ppm)	4.30	4.23	42.50
T_{34}	D3 +Brassinosteroids (0.5µM)	4.90	3.67	45.59
T_{35}	D3 +Brassinosteroids (1.0µM)	4.63	3.80	42.68
T_{36}	D3 + Boron (100ppm)	4.40	4.37	42.89
T_{37}	D3 + Molybdenum (2.0µmol/l)	4.63	3.53	45.71
T_{38}	D3+ GA_3(25ppm)+Boron (100ppm)	4.57	4.30	38.57
T_{39}	D3+ GA_3(50ppm)+Boron(100ppm)	4.13	4.43	37.88
T_{40}	D3+ GA_3(25ppm)+Molybdenum(2.0µmol/l)	4.30	3.63	40.57
T_{41}	D3+ GA_3 (50ppm)+Molybdenum(2.0µmol/l)	4.20	3.70	40.40
T_{42}	D3 +Brassinosteroids (0.5µM)+Boron(100ppm)	4.60	4.23	39.79
T_{43}	D3+Brassinosteroids(1.0µM)+Boron(100ppm)	4.03	4.23	41.87
T_{44}	D3+Brassinosteroids(0.5µM)+Molybdenum(2.0µmol/l)	4.50	3.63	41.72
T_{45}	D3+Brassinosteroids(1.0µM)+Molybdenum(2.0µmol/l)	4.20	3.37	41.04
	SEm ±	0.26	0.20	1.23
	C.D. at 5% level	0.72	0.55	3.47

Table.4 Effect of various plant growth regulators, micronutrients and photothermal regimes on days to 50% flowering, days to first picking and fruit yield (Kg/Plot)

Treat. Symb.	Treatments	Days to 50% flowering	Days to first picking	Fruit yield (Kg/plot)
T_1	D1 +Control	48.39	62.38	23.40
T_2	D1 + GA_3 (25 ppm)	48.36	58.30	30.37
T_3	D1 + GA_3 (50 ppm)	47.29	56.09	31.26
T_4	D1 +Brassinosteroids (0.5µM)	48.08	61.21	27.11
T_5	D1 +Brassinosteroids (1.0µM)	47.48	58.26	33.29
T_6	D1 + Boron (100ppm)	47.70	57.81	30.59
T_7	D1 + Molybdenum (2.0µmol/l)	48.19	62.21	23.82
T_8	D1+ GA_3(25ppm)+Boron (100ppm)	42.20	55.34	43.25
T_9	D1+ GA_3(50ppm)+Boron(100ppm)	40.26	55.19	44.02
T_{10}	D1+ GA_3(25ppm)+Molybdenum(2.0µmol/l)	47.05	57.32	41.04
T_{11}	D1 + GA_3 (50ppm)+Molybdenum(2.0µmol/l)	45.43	56.29	41.21
T_{12}	D1 +Brassinosteroids (0.5µM)+Boron(100ppm)	45.26	56.17	41.18
T_{13}	D1 +Brassinosteroids(1.0µM)+Boron(100ppm)	47.41	58.03	43.55
T_{14}	D1+Brassinosteroids(0.5µM)+Molybdenum(2.0µmol/l)	47.30	57.34	36.32
T_{15}	D1+Brassinosteroids(1.0µM)+Molybdenum(2.0µmol/l)	47.19	57.19	36.61
T_{16}	D2 +Control	52.14	66.23	21.33
T_{17}	D2 + GA_3 (25 ppm)	50.46	63.41	31.15
T_{18}	D2 + GA_3 (50 ppm)	48.23	63.36	32.59
T_{19}	D2 +Brassinosteroids (0.5µM)	50.61	64.67	26.10
T_{20}	D2 +Brassinosteroids (1.0µM)	48.43	63.30	31.69
T_{21}	D2 + Boron (100ppm)	48.47	61.37	25.98
T_{22}	D2 + Molybdenum (2.0µmol/l)	51.27	65.08	22.74
T_{23}	D2+ GA_3(25ppm)+Boron (100ppm)	44.23	57.33	41.14
T_{24}	D2+ GA_3(50ppm)+Boron(100ppm)	44.15	55.83	43.00
T_{25}	D2+ GA_3(25ppm)+Molybdenum(2.0µmol/l)	45.38	59.30	39.64
T_{26}	D2 + GA_3 (50ppm)+Molybdenum(2.0µmol/l)	45.18	58.33	40.27
T_{27}	D2 +Brassinosteroids (0.5µM)+Boron(100ppm)	45.10	58.19	39.01
T_{28}	D2 +Brassinosteroids (1.0µM)+Boron(100ppm)	47.28	61.02	39.81
T_{29}	D2+Brassinosteroids (0.5µM)+Molybdenum(2.0µmol/l)	47.32	60.40	34.47
T_{30}	D2+Brassinosteroids (1.0µM)+Molybdenum(2.0µmol/l)	47.23	60.24	35.46
T_{31}	D3+Control	52.53	65.32	19.18
T_{32}	D3 + GA_3 (25 ppm)	50.62	61.32	29.04
T_{33}	D3 + GA_3 (50 ppm)	48.40	60.33	33.69
T_{34}	D3 +Brassinosteroids (0.5µM)	50.68	61.60	24.70
T_{35}	D3 +Brassinosteroids (1.0µM)	48.54	59.21	29.04
T_{36}	D3 + Boron (100ppm)	48.58	59.37	24.91
T_{37}	D3 + Molybdenum (2.0µmol/l)	55.41	64.38	20.31
T_{38}	D3+ GA_3(25ppm)+Boron (100ppm)	50.45	60.15	39.28
T_{39}	D3+ GA_3(50ppm)+Boron(100ppm)	50.31	60.09	41.65
T_{40}	D3+ GA_3(25ppm)+Molybdenum(2.0µmol/l)	51.46	61.24	37.77
T_{41}	D3+ GA_3 (50ppm)+Molybdenum(2.0µmol/l)	51.21	61.10	40.83
T_{42}	D3 +Brassinosteroids (0.5µM)+Boron(100ppm)	45.42	55.33	38.93
T_{43}	D3+Brassinosteroids (1.0µM)+Boron(100ppm)	47.43	52.22	37.44
T_{44}	D3+Brassinosteroids (0.5µM)+Molybdenum(2.0µmol/l)	47.56	52.41	30.65
T_{45}	D3+Brassinosteroids (1.0µM)+Molybdenum(2.0µmol/l)	47.47	52.40	32.00
	SEm ±	1.43	1.57	2.02
	C.D. at 5% level	4.04	4.43	5.71

Number of primary branches per plant

The maximum number of primary branches per plant was noted under D_1T_9 (5.67) which were transplanted on 15th November with the foliar application of GA_3 (50ppm) + Boron (100ppm) followed by D_1T_8 (5.60) while the minimum number of primary branches was noted under control- D_3T_{31} (3.63). The increase in number of primary branches may be due to promoting effect of GA3 in protein synthesis which consequently enhances biomass production of vegetative parts and their content as reported by Khan *et al.*, (2006). These results are similar to findings of Dhakar and Singh (2015), Meena *et al.*, (2015), Akand *et al.*, (2016) and Jakhar *et al.*, (2018) (Table 2).

Number of flower per cluster

The highest number of flowers per cluster was observed in D_1T_9 (4.93) followed by D_1T_6 (4.87) while the minimum number of flowers per cluster was observed in D_3T_{31} (3.23). Number of flowers per cluster mainly depends on number of branches plant^{-1}. As the GA3 resulted in maximum number of branches per plant therefore number of flower cluster^{-1} was also increased. This result is in accordance with the findings of Islam (2015), Meena *et al.*, (2015)

Days to flower initiation

The maximum days to flower initiation was noted under in D_3T_{31} (45.89) which was control and transplanted on 15th December followed by D_3T_{37} (45.71) while the minimum days to flower initiation was noted under in D_1T_9 (37.59) which were transplanted on 15th November with the foliar application of GA_3 (50ppm) + Boron (100ppm). The probable reason for increase in days to flower initiation is well known to increase hydrolysis of starch and sucrose into glucose and fructose, which were utilized by the flowers for floret opening and boron showed the highest P and K uptake at the pre flowering (P&K) and flowering (P only) stages. This was attributed to the increased photosynthesis and effective translocation of photosynthates. These results are similar to the findings of Gupta and Chakrabarty (2013).

Days to 50% flowering

The maximum days to 50 percent flowering was recorded in D_3T_{37} (55.41) followed by D_3T_{31} (52.53) while the minimum days to 50 percent flowering was recorded in D_1T_9 (40.26). The findings are in close harmony with the result of Jakhar *et al.*, (2018) and Kumar *et al.*, (2018) (Table 3).

Days to first picking

The maximum days to first picking was noted under D_2T_{16} (66.23) followed by D_3T_{31} (65.32) while the minimum days to first picking was noted under D_3T_{43} (52.22) in first year. This might be due to that GA_3 may enhance source to sink relationship, accumulation of photosynthates and efficient utilization of food reserves for the development of fruit and also due to role of boron in flower development, pollen germination, fertilization and fruit abscission. Foliar spray of borax at 60 and 90 DAT closely synchronized with fruit development as it plays role in translocation of carbohydrates to developing fruits.

Fruit Yield (Kg/Plot)

The highest fruit yield per plot was recorded in D_1T_9 (44.02) followed by D_1T_{13} (43.55) while the lowest fruit yield per plot was observed in D_3T_{31} (19.18). this may be due to GA_3 are growth motivating substance which improve the plant growth and development and also increase the fruit set as well as improve yield per plant which ultimately increases yield per plot and increment of paranchymatous cells in pericarp and thickness of vascular tissue as a result of boron treatment led to increase the thickness of pericarp or fruit wall which finally increased the yield. The result is proximate to that of the Khan *et al.,* (2006), Meena *et al.,* (2015) and Akand *et al.,* (2016).

On the basis of this investigation, it is concluded that the treatment GA_3 (50ppm) + Boron (100ppm) (D_1T_9) responded well in terms of growth and yield parameters. Application of foliar spray of the treatment GA_3 (50ppm) + Boron (100ppm) (D_1T_9) were recorded significantly higher morphological growth (viz., plant height, number of primary branches per plant, number of flower per cluster), phenological parameters (viz., days to flower initiation, days to 50% flowering, days to first picking) and fruit yield (Kg/plot).

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