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Effect of plant growth regulators, micronutrients and photothermal regimes on biochemical parameters of brinjal (*Solanum melongena* L.)

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Abstract

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 15th November, 30th November and 15th December to assess the effect on growth and yield of brinjal. The investigation revealed that, the highest dry matter percent in fruit was observed in D_1T_9- GA_3 (50ppm) + Boron (100ppm). The highest total phenol content was noted under D_1T_1 (control) which was transplanted on 15th November and maximum ascorbic acid content was recorded by the treatment combination of GA_3 (25 ppm) + Boron (100 ppm) (D_1T_8).

Keywords: Growth regulators, micronutrients, photothermal regimes, *Solanum melongena* L

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) [21]. According to N. I. Vavilov (1928) [31], the eggplant originated in Indo-Burma region. India is the primary centre of origin (Zeven and Zhukovsky 1975) [33] while secondary diversity in China and South East Asia (Nath *et al*. 1987) [14]. It is a major vegetable crop in several countries India, Japan, Indonesia, China, Bulgaria, Italy, France, The USA and several African countries.

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). The important brinjal growing states are West Bengal, Orissa, Bihar, Gujarat, Maharashtra, Karnataka, Uttar Pradesh and Andhra Pradesh.

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) [28] and it is also a rich source of minerals like potassium, calcium, sodium and iron (Mohamed *et al*, 2003; Raigon *et al*, 2008) [12, 19] as well as dietary fibre (USDA, 2014; Sanchez-Castillo *et al*, 1999) [30, 23]. Brinjal fruits are reported to be a rich source of ascorbic acid and phenolics (Vinson *et al.*, 1998; Somawathi *et al*, 2014; Tripathi *et al*, 2014) [32, 26, 29].

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) [16]. 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) [4] and significantly reduces the number of seeds per fruit. 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) [24, 2, 7] and it is also have ameliorative effect on plants subjected to environmental stress such as cold stress (Liu *et al*., 2009) [10], heat stress (Ogweno *et al*., 2008) [17]. 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) [22].

Material 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 satges of plant on three different date of transplanting (15th November, 30th November and 15th December). The recorded biochemical parameters were dry matter content, total phenol content and ascorbic acid content.

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

Dry matter percent in fruits

A portion of terminal head from randomly marked five plants from each treatment were taken. After chopping, fresh weight was recorded. The samples were oven dried at 60 ºC for 72 hours. Oven dried samples were again weighed and dry matter was expressed in percentage.

Total phenol content (mg/100g) (Thimmaiah, 1999) [27]

Total phenols estimation can be carried out with Folin-Ciocalteu reagent.

Principle: Phenols react with an oxidizing agent phosphomolybdate in Folin –Ciocalteu reagent under alkaline conditions and result in the formation of a blue coloured complex, the molybdenum blue which is measured at 650 nm colorimetrically (Bray and Thorpe, 1954)

Reagents

1) 80% Ethanol
2) Folin-Ciocalteu reagent
3) 20% Na2CO3
4) Standard (100 mg catechol in 100 ml of water). Dilute 10 times for a working standard.

Method

1) Weigh exactly 0.5 to 1g of the sample and grind it with a pestle and morter in 10-15 time volume of 80% ethanol.
2) Centrifuge the homogenate at 10,000 rpm for 20 minutes. Save the supernatant. Re-extract the residue with five times the volume of 80% ethanol, centrifuge and pool the supernatants.
3) Evaporate the supernatant to dryness.
4) Dissolve the residue in a known volume of distilled water (5 ml).
5) Pipette out different aliquots (0.2 to 2 ml) into test tubes.
6) Make up the volume in each tube to 3 ml with water.
7) Add 0.5 ml of Folin-Ciocalteu reagent.
8) After 3 min., add 2 ml of Na2 CO3 solution to each tube.
9) Mix thoroughly. Place the tubes in a boiling water for exactly one minute, cool and measure the absorbance at 650 nm against a reagent blank.
10) Prepare a standard curve using different concentrations of catechol and concentration of phenols in test samples is determined from the standard curve and expressed as mg/100 g material.

Ascorbic acid content (mg/100g) (Rangana, 1976) [20]

Reagents

1. 3% meta phosphoric acid (HPO3): Prepare by dissolving the sticks or pellets of HPO3 in glass distilled water.
2. Ascorbic acid standard: Weigh accurately 100 mg of ascorbic acid and make upto 100 ml with 3% (HPO3). Dilute 10 ml to 100 ml with 3% (HPO3).
3. Dye solution: Dissolve 50 mg of the sodium salt of 2, 6 dichloro phenol indophenols in approximately 50 ml of hot distilled water containing 42 mg of sodium bicarbonate. Cool and dilute with glass distilled water to 200 ml.

Procedure

4. Take 5 ml of standard ascorbic acid solution and 5 ml of HPO3. Fill a microburette with the dye. Titrate with the dye solution to pink colour which should be present for 15 sec. Determine the dye factor i.e. mg of ascorbic acid per ml of the dye.

$$\text{Dye factor} = \frac{0.5}{\text{Titre}}$$

Preparation of sample

Fruit juices: Take 10 to 20 mg of sample and make upto 100ml with 3%HPO3. Filter or Centrifuge.

Assay of extract: Take an aliquot (2-10ml) of the HPO3 extract of the sample and titrate with the standard dye to a pink end point which showed persist for at least 15 sec. the aliquot of sample taken should be such that the titre should not exceed 3-5 ml.

$$\text{Mg of ascorbic acid (mg /100g)} = \frac{\text{Titre} \times \text{dye factor} \times \text{volume made up} \times 100}{\text{Aliquot of extract taken for estimation} \times \text{weight or volume of sample taken for estimation}}$$

Results and Discussion

Dry matter percent in fruits

The highest dry matter percent in fruits was recorded in D_1T_9 (13.20) followed by D_2T_{23} (12.55) while the lowest was recorded in control- D_3T_{31} (5.64) which was transplanted on 15th December. Dry matter content was significantly increased due to application of GA_3 by promoting RNA and protein synthesis, and accelerating enzymes activity responsible for biomass accumulation (Marschner 2012) [11]. This result is in accordance with the findings of Islam (2015) and Akand *et al.* (2016) [8, 1].

Total phenol content

The maximum total phenol content was recorded in D_1T_1 (43.61) followed by D_2T_{16} (42.69) while the minimum total phenol content was recorded in D_1T_{13} (21.33). These results are similar to the finding of Gupta and Solanki (2013) and Shireen *et al.* (2018) [6, 25].

Ascorbic acid content

The highest ascorbic acid content was recorded in D_1T_8 (4.84) followed by D_2T_{23} (4.82) while the lowest ascorbic acid content was recorded in control- D_3T_{31} (1.30) which was transplanted on 15th December. Probable reason for increased ascorbic acid is due to role of GA3 either in biosynthesis of ascorbic acid or protection of synthesized ascorbic acid from oxidation through the enzyme ascorbic acid oxidase. The findings are in close harmony with the result of Chaudhary *et al.* (2006), Ouzounidou *et al.* (2010), Kumar *et al.* (2014), Netam and Sharma (2014) and Gupta *et al.* (2018) [3, 18, 9, 15, 5].

Table 2: Effect of various Plant growth regulators, Micronutrients and Photothermal regimes on dry matter percent, total phenol content and ascorbic acid content in fruits of Brinjal

Treat. Symb.	Treatments	Dry matter content in fruit	Total phenol content (mg/100gm)	Ascorbic acid content (mg/100gm)
T_1	D1 +Control	6.71	43.61	1.38
T_2	D1 + GA_3 (25 ppm)	7.41	37.47	3.03
T_3	D1 + GA_3 (50 ppm)	8.17	40.49	4.05
T_4	D1 + Brassinosteroids (0.5µM)	7.16	27.65	1.73
T_5	D1 + Brassinosteroids (1.0µM)	7.80	31.71	3.50
T_6	D1 + Boron (100ppm)	7.51	22.77	2.13
T_7	D1 + Molybdenum (2.0µmol/l)	6.60	36.63	4.33
T_8	D1+ GA_3(25ppm)+Boron (100ppm)	12.09	22.32	4.84
T_9	D1+ GA_3(50ppm)+Boron(100ppm)	13.20	22.46	4.77
T_{10}	D1+ GA_3(25ppm)+Molybdenum(2.0µmol/l)	9.10	27.32	2.83
T_{11}	D1 + GA_3 (50ppm)+Molybdenum(2.0µmol/l)	9.28	27.32	3.28
T_{12}	D1 +Brassinosteroids (0.5µM)+Boron(100ppm)	9.51	25.10	3.37
T_{13}	D1 +Brassinosteroids(1.0µM)+Boron(100ppm)	11.71	21.33	3.70
T_{14}	D1+Brassinosteroids(0.5µM)+Molybdenum(2.0µmol/l)	8.48	25.43	2.59
T_{15}	D1+Brassinosteroids(1.0µM)+Molybdenum(2.0µmol/l)	8.70	24.52	2.45
T_{16}	D2 +Control	6.61	42.39	1.44
T_{17}	D2 + GA_3 (25 ppm)	7.60	34.52	3.25
T_{18}	D2 + GA_3 (50 ppm)	8.42	36.28	3.59
T_{19}	D2 + Brassinosteroids (0.5µM)	7.14	25.95	1.64
T_{20}	D2 + Brassinosteroids (1.0µM)	7.45	29.34	3.58
T_{21}	D2 + Boron (100ppm)	7.40	25.37	2.25
T_{22}	D2 + Molybdenum (2.0µmol/l)	6.53	23.07	4.30
T_{23}	D2+ GA_3(25ppm)+Boron (100ppm)	12.55	26.78	4.82
T_{24}	D2+ GA_3(50ppm)+Boron(100ppm)	12.38	27.36	4.64
T_{25}	D2+ GA_3(25ppm)+Molybdenum(2.0µmol/l)	9.05	36.81	2.65
T_{26}	D2 + GA_3 (50ppm)+Molybdenum(2.0µmol/l)	9.24	41.74	3.08
T_{27}	D2 + Brassinosteroids (0.5µM)+Boron(100ppm)	9.42	25.50	3.29
T_{28}	D2 + Brassinosteroids(1.0µM)+Boron(100ppm)	10.34	36.40	3.72
T_{29}	D2 +Brassinosteroids(0.5µM)+Molybdenum(2.0µmol/l)	8.33	24.42	2.56
T_{30}	D2+ Brassinosteroids(1.0µM)+Molybdenum(2.0µmol/l)	8.52	38.81	2.44
T_{31}	D3+Control	5.64	42.69	1.30
T_{32}	D3 + GA_3 (25 ppm)	7.12	34.34	3.25
T_{33}	D3 + GA_3 (50 ppm)	8.05	35.55	4.04
T_{34}	D3 + Brassinosteroids (0.5µM)	6.96	27.88	1.60
T_{35}	D3 + Brassinosteroids (1.0µM)	7.35	28.47	3.54
T_{36}	D3 + Boron (100ppm)	7.26	25.91	2.26
T_{37}	D3 + Molybdenum (2.0µmol/l)	6.18	22.99	4.35
T_{38}	D3+ GA_3(25ppm)+Boron (100ppm)	11.52	27.14	4.81
T_{39}	D3+ GA_3(50ppm)+Boron(100ppm)	12.28	26.46	4.72

T_{40}	D3+ GA_3(25ppm)+Molybdenum(2.0µmol/l)	9.02	38.89	2.61
T_{41}	D3+ GA_3 (50ppm)+Molybdenum(2.0µmol/l)	8.48	38.44	3.08
T_{42}	D3 + Brassinosteroids (0.5µM)+Boron(100ppm)	8.67	23.56	3.37
T_{43}	D3+ Brassinosteroids(1.0µM)+Boron(100ppm)	8.77	24.52	3.83
T_{44}	D3+ Brassinosteroids(0.5µM)+Molybdenum(2.0µmol/l)	8.46	25.25	2.49
T_{45}	D3+ Brassinosteroids(1.0µM)+Molybdenum(2.0µmol/l)	8.60	23.56	2.46
	SEm ±	0.47	1.74	0.22
	C.D. at 5% level	1.34	4.92	0.62

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