

# **Analysis of bio- stimulant effectiveness for improved phenotypic attributes and post - harvest life of Asiatic lily cv. Indian Summerset**

## **ABSTRACT**

The study "Analysis of bio- stimulant effectiveness for improved phenotypic attributes and post - harvest life of Asiatic lily cv. Indian Summerset" was conducted at the Research Farm at Department of Horticulture, Sam Higginbottom University of Agriculture, Technology, and Sciences in Prayagraj during the years 2021-22 and 2022-23. The experiment involved thirteen treatments namely triacontanol at concentrations of 10ppm, 15ppm, 20ppm, and 25ppm, brassinolide at concentrations of 5ppm, 10ppm, 15ppm, and 20ppm and nitrobenzene at concentrations of 100ppm, 200ppm, 300ppm, and 400ppm, organized in Randomized Block Design with three replications. These treatments were applied twice at fifteen-day interval. The result revealed that T<sub>5</sub> - triacontanol @ 25 ppm demonstrated the most favorable outcomes concerning plant height (63.3 cm), number of leaves per plant (62.6), leaf area (14.9 cm<sup>2</sup>), and diameter of shoot (12.9 mm) while T<sub>9</sub> - brassinolide @ 20 ppm marked longer vase life (9.8 days).

*Keywords: Asiatic lily, flower, bio-stimulants, triacontanol, brassinolide, nitrobenzene.*

## **Introduction**

Asiatic lilies are an exquisite choice for cut flowers, offering a stunning array of sizes, shapes, colours along with striking trumpet-shaped blossoms (Dole *et al.*, 1999). bio-stimulants have the ability to modify physiological processes in plants, which can play crucial role in enhancing the phenotypic characteristics of Asiatic lilies. Bio-stimulants can be defined as substances and materials that when applied to plants in particular compositions, can alter the physiological processes of plants, offering potential advantages for their growth, development, and responses to stress. They exhibit actions like established plant hormone groups (Yaronskaya *et al.*, 2006) and provide an innovative avenue for regulating and altering physiological processes in plants, with the aim of stimulating growth, alleviating the constraints imposed by various biotic and abiotic stress, and ultimately boosting crop quality and yield. Triacontanol, brassinolide and nitrobenzene positively influence the growth and development of plants. Triacontanol is a potential bio-stimulant. It can effectively improve various physiological parameters of Asiatic lily by influencing the metabolism of plant. Brassinolide is steroidal compound which acts as a vital molecule within the plant part for growth as well as development of

Asiatic lily. Brassinolide are known as sixth-generation plant hormones (Khripach *et al.*, 2000). Nitrobenzene can be described as a pale-yellow oil which have almond-like odour. Flowering crops have been known to respond well to nitrobenzene, as in past, Nitrobenzene has improved the flowering attributes in many plants. Nitrobenzene are new generation plant growth promoter which have crucial role in energizing flowering stimulant and enhancing the yield (Aziz and Miah, 2009).

## **Materials and Methods**

The research project entitled “Analysis of bio-stimulant effectiveness for improved phenotypic attributes and post - harvest life of Asiatic lily cv. Indian Summerset” was carried out during 2021-22 and 2022-23 at Horticulture Research Farm, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology and Sciences, Naini, Prayagraj. the experiment compromised of thirteen treatments which were replicated thrice. The treatments were T<sub>1</sub>- Control, T<sub>2</sub>- 10 ppm Triacontanol, T<sub>3</sub>-15 ppm Triacontanol, T<sub>4</sub>-20 ppm Triacontanol, T<sub>5</sub>- 25 ppm Triacontanol, T<sub>6</sub>- 5 ppm Brassinolide, T<sub>7</sub>-10 ppm Brassinolide, T<sub>8</sub>-15 ppm Brassinolide, T<sub>9</sub>-20 ppm Brassinolide, T<sub>10</sub>-100 ppm Nitrobenzene,

T<sub>11</sub>- 200 ppm Nitrobenzene, T<sub>12</sub>-300 ppm Nitrobenzene, T<sub>13</sub>- 400 ppm Nitrobenzene. Application of bio-stimulants were done two times. The first application was done after fifteen days of planting.

## **Results and discussion**

### **Plant height**

After 40 days of planting significantly taller plants (45.7 cm) were reported in T<sub>5</sub> (triacontanol at the rate of 25 ppm) which was found to be at par with T<sub>4</sub>, (triacontanol at the rate of 20 ppm, 43.4 cm), T<sub>9</sub> (brassinolide at the rate of 20 ppm, 43.2 cm) while T<sub>1</sub> (control,) reported significantly shorter plants (34.6 cm). 60 days after planting, similar results with respect to plant height were obtained, T<sub>5</sub> (triacontanol at the rate of 25 ppm) reported significantly taller plants (63.3cm) which was followed by (triacontanol at the rate of 20 ppm, 58.0 cm) whereas T<sub>1</sub> (control reported significantly shorter plants (47.9 cm). The observed increase in plant height can be attributed to the rapid translocation of triacontanol, facilitating the formation of L adenosine. This, in turn, triggered signals throughout the plant, leading to increased apoplastic ion concentration within stem tissues, promoting shoot development and elongation and consequently increasing plant height (Ries *et al.*, 1990). These findings align with previous research by Koley *et al.* (2019) in gladiolus and Naeem *et al.* (2019) in periwinkle, further supporting the efficacy of triacontanol and bio-stimulants in enhancing plant growth and development

### **No. of leaves**

After 40 days of planting, significantly more number of leaves per plant (56.9) were reported in T<sub>5</sub> (triacontanol at the rate of 25 ppm) which was found to be at par with T<sub>4</sub> (triacontanol at the rate of 20 ppm, 55.5) while T<sub>1</sub> (control) reported significantly lesser number of leaf (40.2). 60 days after planting, similar results with respect to number of leaves per plant (62.6) were reported in T<sub>5</sub> (triacontanol at the rate of 25 ppm) which was at par with T<sub>9</sub> (brassinolide at the rate of 20 ppm, 62.0) whereas T<sub>1</sub> (control) reported significantly lesser number of leaves per plant (49.5). More number of leaves in triacontanol treated plants might be attributed to its role in increasing stomatal conductance and net photosynthesis of the plant. photosynthetic capacity depends on photosynthetic pigment capacity such as accrual of chlorophyll (a, b and a+b) which is induced significantly with application of triacontanol. All these traits significantly influence the internal fixation of CO<sub>2</sub> in the mesophyll tissue thus elevating the number of leaves (Ivanov and Angelov, 1997). Triacontanol positively influences the number of leaf and

nodes of *Capsicum frutescens* (Reddy *et al.*, 2002). Muthuchelian *et al.* (2001) also discussed positive relation with triacontanol in increasing the integration of chlorophyll *a* and *b* along with CO<sub>2</sub> assimilation in Indian coral tree. Similar findings were reported by Bhandari *et al.* (2021) in kohlrabi, Koley *et al.* (2019) in gladiolus and Moorthy and Kathiresan, 1993 in mangrove.

### **Leaf area**

After 40 days of planting significantly bigger leaf area (11.3 cm<sup>2</sup>) were reported in T<sub>5</sub> (triacontanol at the rate of 25 ppm) followed by T<sub>4</sub> (triacontanol at the rate of 20 ppm, 10.1 cm<sup>2</sup>), while T<sub>1</sub> (control) reported significantly shorter leaf area. (7.6 cm<sup>2</sup>). 60 days after planting, similar results with respect to leaf area were obtained, T<sub>5</sub> (triacontanol at the rate of 25 ppm) reported significantly higher leaf area (14.9 cm<sup>2</sup>) which was followed by T<sub>4</sub> (triacontanol at the rate of 15 ppm, 13.4 cm<sup>2</sup>) whereas T<sub>1</sub> (control) reported significantly smaller leaf area (10.3cm<sup>2</sup>). Triacontanol application is involved in stimulation of calcium, magnesium and potassium by elicitation of the messenger adenosine. The elevation in the mineral content of plant may be responsible for the increase in blade length, epidermal cells and chlorophyll which have accounted for increased leaf area. (Naeem *et al.*, 2011). Triacontanol have positive effect on leaf area and bract growth of bougainvillea (Khandakar *et al.*, 2013). These are in conformity with the findings of Skogen *et al.* (2009) in chrysanthemum, Mallick *et al.* (2009) in potato and Reddy *et al.* (2002) in capsicum.

### **Diameter of shoot**

After 40 days of planting significantly larger diameter of shoot (8.8 mm) were reported in T<sub>5</sub> (triacontanol at the rate of 25 ppm) which was found to be at par with T<sub>4</sub> (8.4 mm, triacontanol at the rate of 20 ppm), while T<sub>1</sub> (control) reported significantly shorter diameter of shoot (6.1 mm). 60 days after planting, similar results with respect to diameter of shoot were obtained, T<sub>5</sub> (triacontanol at the rate of 25 ppm) reported significantly larger diameter (12.9 mm) which was at par with T<sub>9</sub> (brassinolide at the rate of 20 ppm, 12.3 mm), T<sub>4</sub> (triacontanol at the rate of 20 ppm, 12.2 mm) whereas T<sub>1</sub> (control) reported significantly smaller diameter (9.4 mm). The increase in diameter of shoot may be due to the fact that triacontanol is linked with the *rbcS* gene levels which helps in increment of the activity of photosynthesis and also improves the status of photosystems which is involved in enhancing water absorption, promoting cell division and elongation, along with improving cell membrane permeability which ultimately increased the girth of the shoot (Borowski *et al.*, 2009). Application of triacontanol has a positive role in increasing the shoot development of the plant (Naeem *et al.*, 2012).

Triacontanol increased the height and leaf area in tomato plants. (Khan *et al.*, 2009). These are in conformity with the findings of Naeem *et al.* (2011) in mint and karam and keramat (2017) in coriander.

### **Vase life**

Longer vase life (9.8 days) reported in T<sub>9</sub> (brassinolide at the rate of 20 ppm) which was followed by T<sub>8</sub> (brassinolide at the rate of 15ppm, 9.4 days) while T<sub>1</sub> (control) reported significantly shorter vase life (6.8 days). Brassinolides have the potential to improve leaf water use efficiency by influencing the carbon capture by Rubisco enzyme along with maintaining the permeability of plasma membrane (Tanveer *et al.*,2018). Another reason could be that respiration rate is inhibited by application of brassinolide along with enhancing the anti-oxidant capacity. Hence, brassinolide application lead to decline in ethylene production increasing post - harvest life of the flower (Zheng *et al.*, 2018). These findings are in support with Kuri *et al.* (2018) in china aster.

### **Conclusion**

On the basis of experimental findings it was concluded that treatment T<sub>5</sub> - triacontanol at the rate of 25 ppm was found most suitable in respect to plant height, number of leaves per plant, leaf area and diameter of shoot while T<sub>9</sub> - brassinolide at the rate of 20 ppm reported longer vase life .

**Table No. 1 Response of bio-stimulants on Plant height and number of leaves per plant  
in Asiatic lily plants**

Treatment	Plant height (cm)						Number of leaves per plant					
	2021-22		2022-2023		Pooled data		2021-22		2022-2023		Pooled data	
	40 days	60 days	40 days	60 days	40 days	60 days	40 days	60 days	40 days	60 days	40 days	60 days
T <sub>1</sub> - Control	33.2	46.9	36.0	47.9	34.6	47.4	41.3	48.3	39.1	50.7	40.2	49.5
T <sub>2</sub> - 10 ppm Triacantanol	39.1	49.7	39.4	56.0	39.2	53.5	47.8	54.4	52.1	53.7	50.0	54.0
T <sub>3</sub> -15 ppm Triacantanol	40.0	52.7	40.9	56.5	40.6	55.3	49.9	59.3	48.8	57.1	49.3	58.2
T <sub>4</sub> -20 ppm Triacantanol	42.8	56.9	44.0	59.8	43.4	58.0	54.1	61.3	56.8	59.3	55.5	59.7
T <sub>5</sub> - 25 ppm Triacantanol	44.8	59.9	49.9	64.1	45.7	63.3	56.7	62.9	57.0	62.5	56.9	62.6
T <sub>6</sub> - 5 ppm Brassinolide	38.8	50.8	37.3	52.0	38.4	51.4	48.3	56.0	44.4	57	46.4	57.2
T <sub>7</sub> -10 ppm Brassinolide	40.0	52.1	37.9	53.3	39.1	52.7	49.7	56.5	45.3	57.1	47.5	58.1
T <sub>8</sub> -15 ppm Brassinolide	41.4	54.7	39.6	55.2	40.5	54.9	50.3	58.3	45.9	55.4	48.1	57.4
T <sub>9</sub> -20 ppm Brassinolide	42.0	56.6	43.0	56.3	43.2	56.5	52.7	61.0	52.6	56.6	52.7	58.0
T <sub>10</sub> -100 ppm Nitrobenzene	34.6	49.4	36.7	51.2	35.6	50.3	43.3	50.3	42.2	55.4	42.7	52.9
T <sub>11</sub> - 200 ppm Nitrobenzene	36.6	51.0	38.8	51.3	37.7	51.1	44.9	51.9	43.6	57.0	44.2	54.6
T <sub>12</sub> -300 ppm Nitrobenzene	38.3	52.4	40.0	51.8	39.2	52.1	46.0	54.9	43.4	57.2	44.7	57.1
T <sub>13</sub> - 400 ppm Nitrobenzene	37.6	53.3	40.9	52.1	39.3	52.7	47.0	56.3	46.2	57.4	46.6	56.5
<b>F- test</b>	<b>S</b>	<b>S</b>	<b>S</b>	<b>S</b>	<b>S</b>	<b>S</b>	<b>S</b>	<b>S</b>	<b>S</b>	<b>S</b>	<b>S</b>	<b>S</b>
<b>S. Ed (±)</b>	2.220	2.695	2.77 4	3.74 2	1.572	2.259	3.006	3.020	1.95 6	2.630	1.940	1.000
<b>CD<sub>0.05</sub></b>	4.583	5.564	5.72 7	7.48 6	3.246	4.663	6.206	6.233	4.03 9	5.430	4.004	1.983
<b>CV</b>	6.92	6.25	7.87	8.16	4.84	5.14	6.54	6.56	4.79	5.52	4.98	2.05

**Table No. 2 Response of bio-stimulants on the leaf area and diameter of shoot in Asiatic lily plants**

Treatment	Leaf area (cm <sup>2</sup> )						Diameter of shoot (mm)					
	2021-22		2022-2023		Pooled data		2021-22		2022-2023		Pooled data	
	40 days	60 days	40 days	60 days	40 days	60 days	40 days	60 days	40 days	60 days	40 days	60 days
T <sub>1</sub> - Control	7.2	10.3	7.9	10.2	7.6	10.3	6.4	9.0	6.1	9.7	6.14	9.4
T <sub>2</sub> - 10 ppm Triacantanol	9.3	11.3	8.8	12.4	9.1	11.8	7.5	11.0	8.0	11.8	7.24	11.4
T <sub>3</sub> -15 ppm Triacantanol	9.4	11.5	8.9	12.5	9.2	12.0	8.2	11.4	8.2	12.5	7.89	12.0
T <sub>4</sub> -20 ppm Triacantanol	10.8	13.6	9.5	13.3	10.1	13.4	8.5	11.9	8.6	13.0	8.43	12.2
T <sub>5</sub> - 25 ppm Triacantanol	12.0	14.4	10.7	15.7	11.3	14.9	8.9	12.9	9.1	13.6	8.86	12.9
T <sub>6</sub> - 5 ppm Brassinolide	8.4	12.3	8.7	12.2	8.5	12.2	7.6	10.6	7.5	11.5	8.23	11.1
T <sub>7</sub> -10 ppm Brassinolide	8.8	12.4	8.7	12.3	8.8	12.4	7.8	10.9	7.7	11.9	7.68	11.4
T <sub>8</sub> -15 ppm Brassinolide	9.3	13.2	8.9	12.3	9.1	12.7	7.9	11.1	7.9	12.1	7.88	11.6
T <sub>9</sub> -20 ppm Brassinolide	9.9	13.3	9.3	12.8	9.6	13.0	8.3	11.3	8.1	12.6	8.06	12.3
T <sub>10</sub> -100 ppm Nitrobenzene	8.2	11.8	8.3	11.7	8.2	11.8	6.6	9.9	6.8	10.2	7.62	10.1
T <sub>11</sub> - 200 ppm Nitrobenzene	8.1	12.0	8.5	11.6	8.3	11.8	6.5	10.2	7.1	10.7	6.91	10.5
T <sub>12</sub> -300 ppm Nitrobenzene	8.5	12.2	8.7	12.1	8.6	12.2	7.4	10.4	7.3	11.3	6.99	10.9
T <sub>13</sub> - 400 ppm Nitrobenzene	8.8	12.6	9.2	12.5	9.0	12.6	7.7	11.3	7.8	12.2	7.65	11.8
<b>F- test</b>	<b>S</b>	<b>S</b>	<b>S</b>	<b>S</b>	<b>S</b>	<b>S</b>	<b>S</b>	<b>S</b>	<b>S</b>	<b>S</b>	<b>S</b>	<b>S</b>
<b>S. Ed (±)</b>	0.656	0.719	0.633	0.938	0.463	0.558	0.466	0.74	0.56	0.695	0.293	0.436
<b>CD<sub>0.05</sub></b>	1.354	1.484	1.308	1.937	0.957	1.153	0.962	1.527	1.157	1.435	0.606	0.900
<b>CV</b>	8.75	7.15	8.64	9.20	6.26	5.52	7.43	8.29	8.9	7.25	4.70	4.70

**Table No.3 Effect of bio-stimulants on vase Life in Asiatic lily plants**

<b>Treatment</b>	<b>Vase life</b>		
	<b>2021-22</b>	<b>2022-23</b>	<b>Pooled data</b>
T <sub>1</sub> - Control	6.6	7.1	6.8
T <sub>2</sub> - 10 ppm Triacontanol	6.7	7.4	7.1
T <sub>3</sub> -15 ppm Triacontanol	7.7	7.9	7.8
T <sub>4</sub> -20 ppm Triacontanol	7.7	8.0	7.8
T <sub>5</sub> - 25 ppm Triacontanol	8.7	8.9	8.8
T <sub>6</sub> - 5 ppm Brassinolide	7.9	8.1	8.0
T <sub>7</sub> -10 ppm Brassinolide	8.7	8.5	8.6
T <sub>8</sub> -15 ppm Brassinolide	9.1	9.7	9.4
T <sub>9</sub> -20 ppm Brassinolide	9.8	9.9	9.8
T <sub>10</sub> -100ppm Nitrobenzene	8.6	8.6	8.6
T <sub>11</sub> - 200 ppm Nitrobenzene	8.0	8.4	8.2
T <sub>12</sub> -300ppm Nitrobenzene	8.7	9.2	9.0
T <sub>13</sub> - 400 ppm Nitrobenzene	9.1	9.1	9.1
<b>F-test</b>	<b>S</b>	<b>S</b>	<b>S</b>
<b>S. Ed (±)</b>	0.375	0.493	0.385
<b>CD<sub>0.05</sub></b>	0.775	1.018	0.795
<b>CV</b>	5.57	7.09	5.63

## Refernces

**Aziz, M.A. and Miah, M.A. (2009).** Effect of flora on the growth and yield of wetland rice. *Journal of Agricultural Research and Development*, **12**(1): 112-120.

**Bhandari, S., Bhandari, A. and Shrestha, J. (2021).** Effect of different doses of triacontanol on growth and yield of kohlrabi (*Brassica oleraceae var gongylodes*). *Plant Physiology Plant Molecular Biology*, **49**(1): 427-432.

**Borowski, E. and Blamowski, Z.K. (2009).** The effects of triacontanol 'TRIA' and Asahi SL on the development and metabolic activity of sweet basil (*Ocimum basilicum*) plants treated with chilling. *Acta Horticulture*, **21**(1): 39-48.

**Dole, J. M., Harold, F. and Wilkins, P. (1999).** Floriculture Principles and Species. Prentice Hall Inc, Upper Saddle River, New Jersey: 613. *International Journal of Botany Studies*, **4**(2): 421-426.

**Ivanov, A.G. and Angelov, M.N. (1997).** Photosynthesis response to triacontanol correlates with increased dynamics of mesophyll protoplast and chloroplast membranes, *Plant Growth Regulation*, **21**(2): 145-152.

**Karam, E.A. and Keramat, B. (2017).** Foliar spray of triacontanol improves growth by alleviating oxidative damage in coriander under salinity. *Indian Journal of Plant Physiology*, **22**(1): 301-308.

**Khan, M., Aftab, M. and Naeem, M. (2010).** Synergistic effects of gibberellic acid and triacontanol growth, physiology, enzyme activities and essential oil content of *Coriandrum sativum* L. *The Asian and Australian journal of plant science and biotechnology*, **4**(1): 24-29.

**Khandeker, M.M., Faruq, G., Rahman, M., Azirun, M.S. and Boyce, A.N. (2013).** Potted bougainvillea plants (*Bougainvillea glabra* var. Elizabeth Angus) under natural conditions. [\*The Scientific World Journal\*](#), **12** (7): 156-162.

**Khripach, V., Zhabinskii, V. and Groot, A. (2000).** Twenty years of brassinosteroid: steroidal plant hormones warrant better crops for the XXI century. *Annals of Botany*, **86**: 441-447.

**Koley, P., Maitra, S. and Sarkar, I. (2019).** Studies on the exogenous application of plant growth regulators on morphological and biochemical changes in gladiolus (*Gladiolus grandiflorus*) Leaf. *International Journal of Current Microbiology and Applied Sciences*, **8**(9): 1869-1877.

**Kuri, B.R., Jat, N.L., Shivran, A.C., Saharawat, Y.S. and Dadarwal, R.S. (2015).** Effect of sowing time, varieties and plant growth, physiological indices and productivity of coriander (*Coriandrum sativum*). *Indian Journal of Agronomy*, **60**(3): 464-470.

**Kuri, S., Bahadur, V., Prasad, V.M., Bander, A.N. and Niranjana, R. (2018).** Effect of plant growth regulators on vegetative, floral and yield characters of China aster. (*Callistephus chinensis*) cv. Phule Ganesh Purple. *International Journal of Chemical Studies*, **6**(4): 3165-3169.

**Mallick, S., Ghosh, R. K. and Pal, D. (2009).** Effect of triacontanol on the growth and yield of potato. *Journal of Crop and Weed*, **5**(2): 154-156.

**Moorthy, P. and Kathiresan, K. (1993).** Physiological responses of mangrove seedling to triacontanol. *Biologia Plantarum*, **35**(4): 577-581.

**Muthuchelian, K. C., Murugan, N., Nedunchezian, D. and Kulandaivelu, G. (1997).** Photosynthesis and growth of *Erythrina variegata* as affected by water stress and triacontanol. *Photosynthetica*, **33**(2): 241-248.

**Muthuchelian, K., Bertamini, M. and Namachevayam, N. (2001).** Triacantanol can protect *Erythrina* from cadmium toxicity. *Journal of Plant Physiology*, **158**(11): 1487-1490.

**Naeem, M. M., Khan, M. A., Moinuddin, M., Idrees, M. and Aftab, T. (2011).** Triacantanol mediated regulation of growth and other physiological attributes, active constituents and yield of *Mentha arvensis*. *Plant Growth Regulation*, **65**(1): 195-206.

**Naeem, M.M., Khan, A. and Moinuddin, A.S. (2012).** Triacantanol: A potent plant growth regulator in agriculture. *Journal of Plant Interactions*, **7**(2): 129-142.

**Naeem, M., Ansari, A.A., Aftab, T. and Shabbir, A. (2019).** Application of triacantanol modulates plant growth and physiological activities of *Catharanthus roseus* L.

**Reddy, B.O., Giridhar, P. and Ravishankar, G. A. (2002).** The effect of triacantanol on micropropagation of *Capsicum frutescens* and *Decalepis hamiltonii*. *Plant Cell, Tissue and Organ Culture*, **71**(3): 253-258.

**Ries, S., Wert, V., Leary, D. and Nair, M. (1990).** Adenosine: a new naturally occurring plant growth substance elicited by triacantanol in rice. *Plant Growth Regulation*, **9**: 263-273.

**Skogen, D., Eriksen, A. B. and Nilsen S. (1982).** Effect of triacantanol on production and quality of flowers of *Chrysanthemum moriolium*. *Scientia Horticulturae*, **18**(1): 87-92.

**Tanveer, M., Shahzad, B., Sharma, A. and Biju, S. (2018).** 24-Epibrassinolide; an active brassinolide and its role in salt stress tolerance in plants. *Plant Physiology and Biochemistry*, **3**: 130-133.

**Yakhin, O.I., Lubyantsev, A.A., Yakhin, I.A. and Brown, P.H. (2017).** Bio-stimulants in plant science: A global perspective. *Frontiers in Plant Science*, **7**(2): 1-32.

**Yaronskaya, E., Vershilovskaya, I. Poers, Y., Alawady, A.E., Averina, N. and Grimm, B. (2006).** Bio-stimulants effects on biosynthesis and photosynthetic activity in barley seedlings. *Journal of Experimental Botany*, **22**(4): 700-709.

**Zheng, L., Ma, J., Li, Z., Gao, C., Zhang, D., and Zhao C. (2018).** Revealing critical mechanisms of BR-mediated apple nursery tree growth using iTRAQ-based proteomic analysis. *Journal of Proteom.* **17**(3): 139-154.

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