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Effect of plant growth regulators on growth, flowering and yield of ridge gourd (*Luffa acutangula* L. Roxb.) *cv*. Kashi Shivani

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Abstract
A field study was carried out on ridge gourd during 2021 February to May on Experimental Unit, Pilikothi, Department of Horticulture, Tilak Dhari Post Graduate College, Jaunpur, Uttar Pradesh. The experimental field was laid out in randomized block design (R.B.D.) with ten treatments of different concentrations of three kinds of Plant growth regulators, namely NAA, GA_3 and Ethrel with just one variety replicated thrice. The variety used in this study was Kashi Shivani (IIVR). The experiment comprised of nine foliar applications consisting of T_1: NAA 50 ppm, T_2: NAA 75 ppm, T_3: NAA 100 ppm, T_4: GA_3 100 ppm, T_5: GA_3 150 ppm, T_6: GA_3 200 ppm, T_7: Ethrel 100 ppm, T_8: Ethrel 150 ppm, T_9: Ethrel 200 ppm with T_0: Control. Results revealed that the maximum vine length at harvesting stage (523.57), maximum number of male flowers (150.35) and minimum days taken to opening of first male flower (33.4 days) was observed with GA_3 200 ppm and maximum number of branches (14.31), earliest opening of female flower (37.83 days), maximum number of female flowers (28.04), minimum days taken to first harvesting (50.3 days), maximum number of fruits per vine (26.19), maximum fruit length (29.45 cm), maximum girth of fruit (14.41 cm), maximum average fruit weight (146.43 g), maximum yield of fruit per vine (3.93 kg/vine), maximum yield of fruit per plot (47.27 kg) and maximum fruit yield per hectare (184.31 q/ha) was observed in treatment T_9: Ethrel 200 ppm.

Keywords: Growth, yield, flowering, plant growth regulators, ridge gourd

Introduction
Ridge gourd [*Luffa acutangula* (Roxb.) L.] is a dark green, fleshy cucurbitaceous vegetable and grows in vines. It belongs to order- Cucurbitales and family- cucurbitaceae. It is believed to have originated in India and having diploid chromosome number 2n=2x=26. It is an important tropical and sub-tropical cucurbitaceous vegetable, it's originated in sub-tropical Asian region including India (Bhat *et al*., 2018). Locally it is called as "Sirola" (Gujarati), "Koshataki" (Sanskrit), "Dodka" (Marathi), "Beerakaya" (Telugu), "Turai" (Hindi) "Peerkankai" (Tamil), Heerekayi (kannada), peechanga (Malayalam) assamese" Jika", "Jhinga", "Ribbed gourd" and also called "Chinese okra". Apart from India, it is called ''Sigua" in China," Patola" in Philliines," Thaboot Thee" in Myanmar and "Loofa" in Egypt. It is grown as summer and rainy season crop.

The name "Luffa" or "Loofah" is an Arabic origin and refers to the spongy characteristic of the mature fruit. It contains a gummy compound called "Luffein", which has medicinal importance (Bose and Som, 1986) [1]. Fruit is diuretic and nutritive. It acts as Anti Oxidants and purifies blood. It is having properties of controlling diabetes and solve constipation related stomach disorders since it is rich in fibre. It is beneficial for jaundice patients and cure tetanus. It's fruits are beneficial for those people, who suffer from malaria and other seasonal fever for its easy digestibility and very appetizing quality (Yawalkar, 1985) [11].

Every 100g of edible portion of fruit contain, 0.5g of protein, 0.5% of fibre, 3.5% of carbohydrate, 37 mg of carotene, 5.0mg of vitamin C, 18 mg of calcium and 0.5 mg of iron (Krishnamoorthy and Ananthan, 2017) [7]. Seeds of ridge gourd are contains 18 to 25% protein and 18.3 to 24.3% oil.

It is a climber with acutely 5 angled stem, hairy tendrils, 5-7 angled or shallowly lobed leaves. The sex forms in Ridge gourd are monoecious, androecious, gynoecious, gynomonoecious, andromonoecious and hermaphrodite. Ridge gourd is predominantly monoecious in nature where raceme staminate and solitary pistillate flowers are found on the same nodes.

The flowers are pale yellow and anthesis takes place in evening and remains open throughout the night. Stigma is receptive 6 hour before to 84 hours after anthesis (Singh, 1957). Fruit are club shaped and ribbed. There is wide variability in fruit shape and size. Seeds are black in colour and pitted. Because of hard rind of mature fruits, it is known as gourd (Ram, 2012).

Plant growth regulators are organic substances other than nutrients, which in minute concentration increase, decrease or modify the physiological process of the plant. The effect of growth regulator varies with plant species, variety, their growth stages, concentration of chemicals, application method and frequency of application.

NAA is used in chemical thinning and prevention of fruit drop or induction of flowering, increase fruit setting, size and thus increasing yield. NAA interacts at the gene level by synthesizing enzymes required for the synthesis of cell wall and cytoplasmic components. NAA initiate uniform flowering.

Gibberellins are synthesized in young tissues of the shoots, as well as in roots and developing seeds. They are used for embolden cell enlargement, rupturing the seed dormancy in some plants which requires light for germination, embolden alpha- amylase production in germinating cereal grains, emboldens bolting/flowering in response to long days, induces maleness in dioecious flowers, play an important role in development of seedless fruit. (Prajapati *et al*., 2015) [9].

Ethylene is the only gaseous hormone which stimulates growth. Its liquid form is ethrel. Exogenous application of ethylene outcome in enhanced morphogenesis of flower organs, early flowering, fruiting, ripening and ultimately increases in crop yield. It increase fruit set, seed germination, induces production of female flowers and induces male sterility and inhibits the vegetative growth and rise reproductive growth. Ethylene is responsible for breaking the dormancy. It promotes the senescence of leaves and flower. The role of ethylene was greater in female buds than from male buds (Kooner *et al*. 2000) [8].

Method and Material

The present investigation entitled "Effect of Plant Growth Regulators on Growth, Yield and Quality of Ridge gourd (*Luffa accutangula* L. Rox*b.*) *cv.* Kashi Shivani" was conducted at Experimental unit, Pilikothi farm, Tilak Dhari Post Graduate College, Jaunpur Uttar Pradesh during spring season, 2021. The healthy hybrid seed of Ridge gourd *cv.* Kashi Shivani were bought from Indian Institute of Vegetable Research (IIVR), Varanasi, Uttar Pradesh. The seeds of ridge gourd were sown in the second week of February with spacing of 3m x 0.75m. The climatic condition of Jaunpur is sub-tropical. Geographically Jaunpur is situated in eastern part of Uttar Pradesh which lies between 25 ^{0}44' North latitude and 82^{0}41' East longitude at an elevation of 83.230 meter above mean sea level. The seeds of ridge gourd were sown 1.5 to 2 cm depth in sandy loam soil having pH 7.2. The experiment was comprised of 9 treatment combination with different Plant growth regulators (Control, NAA, GA_3, Ethrel) and control (water spray) *viz*. comprised of nine foliar applications consisting of T_1: NAA @ 50 ppm, T_2: NAA @ 75 ppm, T_3: NAA @ 100 ppm, T_4: GA_3 @ 100 ppm, T_5: GA_3 @ 150 ppm, T_6: GA_3 @ 200 ppm, T_7: Ethrel @ 100 ppm, T_8: Ethrel @ 150 ppm, T_9: Ethrel @ 200 ppm with T_0: Control. The experiment was laid out in Randomized Block Design (RBD) with three replication. All the treatments were randomized separately in each replication. The required quantity of plant growth regulators as per treatment was applied at 2nd and 4th leaf stage of crop. After weighing, the growth regulators were dissolved in a tiny amount of 95% absolute alcohol. Each growth regulator's stock solution was first produced by diluting it with distilled water. Further dilutions of the measured volume of stock solution with distilled water were used to create the desired concentration solution. Spraying was done per the treatment for each plant, using an equal volume of solution for each. A compressed air hand sprayer was used to spray in the evening. The control plant was sprayed with distilled water. Statistical analysis of variance was performed on the data collected throughout the experiment. The significance of the treatments was determined using the 'F' test at a level of significance of 5%

Result and Discussion

Growth parameters

1. From the table 1 the maximum vine length was observed in T_6: GA_3 @ 200 ppm (138.48, 345.66 and 523.57 cm, respectively at 30, 60 DAS and at harvesting stage). Whereas, minimum vine length at 30,60 DAS and at harvesting stage (113.67, 205.62 and 460.43 cm, respectively) were observed under control (T_0). The boost of growth in terms of enhancement in the vine length has been thought to be by increasing plasticity of the cell wall followed by hydrolysis of starch to sugar which slacken the water potential of cell resulting in the entry of water into the cell causing enlargement. These osmotic driven responses under the effect of Gibbrellins might have attributed to rise in photosynthetic activity, accelerated translocation and efficiency of utilizing photosynthetic products, thus resulting in increased cell enlargement and rapid cell division in the growing portion. Similar result are found by Chaurasiya *et al.* (2016) [2] reported maximum vine length with spraying of GA_3 @ 60 ppm in muskmelon, Kadi *et al*. (2018) [5] reported maximum vine length with spraying of GA_3 @ 100 ppm in cucumber and Dalai *et al.* (2015) [3] and Kumari *et al*. (2019) [6] reported maximum vine length with the application of GA_3 @ 100 ppm in bottle gourd.

   Number of branches at final harvest time was recorded maximum (14.31) per vine with treatment T_9: Ethrel @ 200 ppm. Whereas, the minimum number of branches found in control T_0 (9.16). This favourable effect of Ethrel on number of branches per vine and vine length of ridge gourd due to its adverse effect on Auxin, which enforces apical dominance and suppression of lateral buds to sprout. These results are in close conformity with the experiment reported by Kumari *et al.* (2019) [6] they reported decrease in vine length and increase in number of branches with the application of Ethrel @ 200 ppm in bottle gourd, Chaurasiya *et al*. (2016) [2] who reported reduced in vine length but improved in branches with application of Ethrel @ 200 ppm in muskmelon and Hilli *et al*. (2010) [4] who obtained the maximum number of branches per vine in ridge gourd with spraying of Ethrel @ 500 ppm.

Table 1: Effect of plant growth regulators on vine length of ridge gourd at 30 DAS, 60 DAS, at harvesting stage and on number of branches/vine

Treatment	Plant Growth Regulators	vine length of ridge gourd at 30 DAS	vine length of ridge gourd at 60 DAS	vine length of ridge gourd at harvesting stage	Number of branches per plant at harvesting stage
T_0	Control	114.39	305.72	460.53	9.16
T_1	NAA 50 ppm	120.19	315.04	491.85	10.2
T_2	NAA 75 ppm	119.16	318.15	480.49	10.77
T_3	NAA 100 ppm	121.36	325.68	488.11	11.24
T_4	GA_3 100 ppm	126.22	328.57	498.31	10.93
T_5	GA_3 150 ppm	132.48	335.66	507.81	11.51
T_6	GA_3 200 ppm	138.48	345.65	523.57	12.3
T_7	Ethrel 100 ppm	116.98	317.19	470.51	11.85
T_8	Ethrel 150 ppm	118.58	311.93	478.92	13.07
T_9	Ethrel 200 ppm	117.85	322.92	475.3	14.31
S.Em±		0.229	0.085	0.367	0.282
CD (P= 0.05)		0.684	0.253	1.10	0.094

Flowering parameters

From table 2 the maximum number of female flower (26.04) was observed in treatment T_9: Ethrel @ 200 ppm. Whereas, the minimum number of female flower (15.25) was found in control T_0. Earliest opening of first female flower (37.83 days) was observed in treatment T_9: Ethrel @ 200 ppm. Whereas maximum days taken to opening of first female flower (42.53) was found in control (T_0). The sexual differentiation is governed by endogenous level of Auxins that develop flowers premordial and act as anti-gibberellin substance during which suppress staminate flowers and promotes more number of pistiliate flowers (Sulochanamma, 2001) [10]. This might also be due to the build-up of high carbohydrate reserves in plant receiving various foliar application of Ethrel, resulting in early flowering as well as increased number of female flower and fruit set.

The maximum number of male flower (150.35) was observed in treatment T_6: GA_3 @ 200 ppm. Whereas, the minimum number of male flower per vine (124.88) was found in T_9: Ethrel @ 200 ppm. Minimum days to taken opening of first male flower (33.4) was observed in T_6: GA_3 @ 200 ppm. Whereas maximum days taken to opening of first male flower (37.5) was found in T_0. Similar results were found by Kadi *et al.* (2018) [5] in cucumber and Kumari *et al.* (2019) [6] in bottle gourd.

Table 2: Effect of plant growth regulators on number of male flowers per vine, number of female flowers per vine at harvesting stage of ridge gourd, days taken to opening of first male flower and days taken to opening of first female flower

Treatment	Plant Growth Regulators	Number of male flowers per vine	Number of female flowers per vine	Days to taken opening of first male flower	Days to taken opening of first female flower
T_0	Control	144.48	15.25	37.5	42.53
T_1	NAA 50 ppm	129.4	19.17	36.28	40.85
T_2	NAA 75 ppm	131.35	20.47	35.67	39.92
T_3	NAA 100 ppm	134.35	22.92	35.07	39.06
T_4	GA_3 100 ppm	136.87	20.61	35.45	41.48
T_5	GA_3 150 ppm	138.35	22.85	34.42	40.95
T_6	GA_3 200 ppm	150.35	18.95	33.4	40.43
T_7	Ethrel 100 ppm	128.83	20.5	36.46	40.18
T_8	Ethrel 150 ppm	127.47	24.27	35.94	38.6
T_9	Ethrel 200 ppm	124.88	28.04	35.43	37.83
S.Em±		0.271	0.631	0.210	0.068
C.D. (P= 0.05)		0.091	0.211	0.630	0.205

Yield parameters

From table 3 the maximum number of fruits (26.19) per vine was observed in treatment T_9: Ethrel @ 200 ppm. Whereas, the minimum number of fruits (12.3) per vine was found in control (T_0). The maximum fruit length (29.45 cm) was observed in T_9. Whereas, control recorded minimum fruit length (18.95). Among the application of different combination of plant growth regulators, treatment T_9: Ethrel @ 200 ppm had maximum effect on girth of fruits (14.41 cm). While, the minimum girth of fruits was observed in control T_0 (4.18). The beneficial effect of Ethrel on fruit girth may be explained as that exogenous application of Ethrel increased indogenous levels of Auxins. The enlargement of cells of the fruit by Auxins is diametric leading to the simultaneous increase in fruit diameter.

The fruit weight also increased significantly with the application of different combination of plant growth regulators. The treatment T_9 proved most effective for increasing average weight of fruit (146.43 g). The minimum average fruit weight was found in control (105.4g). The maximum yield of fruits (3.93 kg) per vine was recorded in T_9. The minimum fruit yield was observed in T_0 (1.34 kg). The maximum yield of fruits per plot (47.27 kg) was recorded in treatment T_9: Ethrel @ 200 ppm. Minimum fruit yield per plot (16.14 kg) was found in control (T_0). The maximum yield per hectare of fruits (184.31 quintal) was recorded in treatment T_9: Ethrel @ 200 ppm. The minimum fruit yield per hectare was observed in T_0 (62.95 quintal). This might be due to an increased rate of photosynthetic activity to build-up sufficient food stock, accelerated transport, efficient utilization of

photosythetic products. Similar result are reported by Kumari *et al*. (2019) [6] in bottle gourd, in bottle gourd, in cucumber, Soni *et al*. (2016) in biottle gourd, Chaurasiya *et al.* (2016) [2] in muskmelon, in ridge gourd, in cucumber, in round melon and Shweta *et al*. (2015) bottle gourd.

Table 3: Effect of plant growth regulators on number of fruits per vine, girth of fruit (cm), length of fruit (cm), Average weight of fruit (g), Fruit yield/vine (Kg), Fruit yield /plot (Kg), Fruit yield (q/ha) of ridge gourd

Treatments	Plant growth regulators	Number of fruits per vine	Length of fruit (cm)	Girth of fruit (cm)	Average weight of fruit (g)	Fruit yield per vine (Kg)	Fruit yield per plot(kg)	Fruit yield (q/ha)
T_0	Control	12.3	18.95	4.18	109.4	1.34	16.14	62.95
T_1	NAA 50 ppm	15.02	21.77	7.6	124.48	1.86	22.43	87.47
T_2	NAA75 ppm	16.47	22.68	8.79	128.1	2.10	25.31	98.70
T_3	NAA 100 ppm	20.92	25.6	11.12	142.1	2.97	35.67	139.07
T_4	GA_3 100 ppm	16.61	20.07	6.37	121.86	2.02	24.28	94.69
T_5	GA_3 150 ppm	18.85	21.63	7.58	124.16	2.34	28.08	109.49
T_6	GA_3 200 ppm	14.1	21.19	7.75	124.86	1.76	21.12	82.36
T_7	Ethrel 100 ppm	17.65	22.2	8.78	128.23	2.26	27.15	105.88
T_8	Ethrel 150 ppm	23.42	23.32	9.1	134.98	3.16	37.93	147.89
T_9	Ethrel 200 ppm	26.19	29.45	14.41	150.43	3.93	47.27	184.31
S.Em±		0.004	0.241	0.027	0.705	0.068	0.789	1.028
CD (P=0.05)		0.012	0.721	0.082	2.112	0.023	0.263	3.078

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