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Study on the effect of foliar spray of NAA, GA3 and Ethrel on yield and yield attributing traits of ridge gourd (*Luffa acutangula*)

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Abstract
A field experiment entitled effect of foliar spray of NAA, GA3 and Ethrel on yield and yield attributing traits of ridge gourd (*Luffa acutangula*) was conducted at Sam Higgin bottom University of Agriculture, Technology & Science, involving two distinct varieties of ridge gourd, namely TMRG 1509 and Ridge gourd Check Aneeta. 12 combinations were applied, consisting of various concentrations of GA3 (50 to 200 ppm), Ethrel (50 to 150 ppm), and NAA (50 to 200 ppm), along with a control group receiving a water spray. The growth regulators were administered at three different growth stages, including four-leaf and flower initiation, flower and fruit initiation, and four-leaf, flower, and fruit initiation. The experimental design employed a Randomized Block Design with a Factorial concept.

The results of the study revealed significant variations in yield and yield attributing traits of the two ridge gourd varieties in response to the different treatments and growth stages. Overall, the application of GA3 at 200 ppm during the flower and fruit initiation stage exhibited the highest increase in yield and several yield attributing traits, such as fruit size, number of fruits per plant, and average fruit weight, for both ridge gourd varieties. Results revealed that maximum vine Length (300.27 cm), germination percentage (96.67%), Seed Index (12.62), number of seed per fruit (129.60), fruit weight (147.78) TSS (1.35) and Ascorbic acid (11.00) is recorded in Treatment with GA3 200 ppm. The maximum number of fruits per vine (13.60), fruit Girth (38.20 mm) and fruit yield per Vine (2.09kg) is recorded in Treatment with Ethrel 200 ppm. The maximum fruit Length (29.08cm), days taken for flower initiation male (38.20) female (44.40) was recorded in Treatment with NAA 200 ppm. Ethrel and NAA treatments also showed positive effects on yield and yield attributes, albeit to a lesser extent.

Keywords: Ethrel, NAA, GA3, PGR, yield, ridge gourd

Introduction
Ridge gourd, scientifically known as Luffa acutangula, has a chromosome count of 2n=26 and belongs to the Cucurbitaceae family. Widely cultivated in India, it serves both medicinal and culinary purposes. Its freshly harvested fruits are a staple in daily diets, boasting nutritional content such as 0.5g of fiber, 0.5 percent protein, 0.34 percent carbohydrate, 37 mg carotene, 5.0 mg vitamin C, 18 mg calcium, and 0.5 mg iron per 100 g of edible portion (Hazra and Som, 2017) [24]. Due to its significance in people's diets, there's a growing need to improve crop productivity through better management practices and seed quality. However, ridge gourd cultivation faces challenges, particularly concerning the excessive use of fertilizers, which diminishes profitability for farmers. Failure to supply timely and adequate doses of fertilizers results in decreased yield and nutritional quality.

Material and Methods
A field experiment entitled "Study on the Effect of Foliar spray of NAA, GA3 and Ethrel on Yield and Yield attributing Traits of Ridge Gourd (Luffa acutangula)" was carried out during Kharif season of the year 2023. The study took place at the Horticulture Research Farm within the Department of Horticulture at Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology & Sciences, Prayagraj (UP) between 2023 and 2024. The Department provided all essential resources for cultivation, including labor. This experiment was planned with two factors i.e. 1. Variety (V) and 2. Different doses of plant growth regulators (T) with 3 Replications under Factorial Randomized Block Design.

The different doses of Plant growth regulators were T_0 (Control), T_1 (GA3 50 ppm), T_2 (GA3 100 ppm), T_3 (GA3 150 ppm), T_4 (GA3 200 ppm), T_5 (NAA 50 ppm), T_6 (NAA 100 ppm), T_7 (NAA 150 ppm), T_8 (NAA 200 ppm), T_9 (Ethrel 50 ppm), T_{10} (Ethrel 100 ppm), T_1 (Ethrel 150 ppm) and T_{12} (Ethrel 200). and the different varieties used in the experiment are V1(Aneeta) and V2 (TMRG-1509).

Climate and Weather Conditions

Prayagraj is situated at an elevation of 78 meters above sea level, positioned at 25.87 degrees North Latitude and 81.15 degrees East Longitude. This area experiences a subtropical climate, located in the southeastern part of Uttar Pradesh. It encounters both extremes of temperature, with cold winters and hot summers. In the chilly winters, temperatures can drop as low as 32 degrees Fahrenheit in December and January, while summers can be scorching, with temperatures soaring up to 115 degrees Fahrenheit in May and June. Frost is common during winters, and hot, drying winds are prevalent during the summer months. The average annual rainfall is approximately 1013.4 millimeters, with the heaviest rainfall typically occurring from July to September, although occasional showers can also happen during winters.

Results and Discussion

Growth Parameters

Germination

The data on germination as influenced by Plant growth regulator in different treatment combinations was recorded. Critical analysis of data displayed in the table clearly marked out the obvious differences among the treatments with respect to germination.

The germination was observed during the vegetative growth. The observations of germination as influenced by different levels of foliar spray of Plant Growth regulators are tabulated. Among the different treatments of plant growth regulator the maximum no of days taken to germinate was recorded in T_0 (Control) in variety TMRG 1509 (7.45) with germination % of (77.78%) and Minimum No. of days was recorded in variety Aneeta with Treatment GA3 200 ppm (5.47) with germination % of (100%).

Seed Index

The Maximum Seed Index was recorded in the variety TMRG 1509 with Treatment GA3 200 ppm (13.00) followed by variety Aneeta with Treatment NAA 100 ppm (12.80) and Minimum was recorded in the variety TMRG with Treatment GA3 200 ppm (10.53). Further, Gedam *et al*., (1996) [31] reported significantly higher number of seeds, 100 seed weight and vigour index by spraying of NAA at 100 ppm as compared to control in bitter gourd.

Fruit Weight

The Maximum Fruit Weight (g) was recorded in the Variety Aneeta with Treatment Ethrel 100 ppm(170.63g) followed by variety Aneeta with Treatment GA3 200 ppm(159.47g) and Minimum was recorded in the variety TMRG – 1509 control treatment (99.17g). An increase in fruit weight may be attributed to the reason that plant remained physiologically more active to build up sufficient food stock for developing flowers and fruits, ultimately leading to higher fruit weight, number of fruits/vine and yield. These findings are in conformity with those of Kshirsagar *et al*. (1996) [25] in cucumber, Kumar *et al*. (2006) [26, 27] in bottle gourd and Jadav *et al*. (2010) [28] in cucumber.

Fruit Length

The Maximum Fruit Length (cm) was recorded in the Variety TMRG 1509 with Treatment GA3 200 ppm (30.03cm) followed by variety TMRG 1509 with Treatment Ethrel 200 ppm (29.67cm) and Minimum was recorded in the variety Aneeta control treatment (21.67 cm). The fruit and seed traits were also highest in GA3 treated plants which could be due to better enzyme induction and endogenous synthesis of growth regulators. Similar findings were reported by (Akter and Rahman 2010) [30].

Fruit Girth

The Maximum Fruit Girth (mm) was recorded in the Variety Aneeta with Treatment GA3 200 ppm (39.67 mm) followed by Ethrel 100 ppm (38.33 mm) and Minimum was recorded by Variety Aneeta control Treatment (28.80 mm). 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. Similar result are reported by Kumari *et al*. (2019) [32].

Male Flower Initiation

The maximum days to male flower initiation was recorded in the variety TMRG-1509 control Treatment (37.67) followed by NAA 200 ppm (37.33) and minimum was recorded by variety Aneeta with Treatment GA3 200 ppm (30.67). These results are conformity with the findings of Ghosh and Basu (1982) [33] who reported that GA3 40 ppm and Ethrel 25 ppm applied at 8-10 leaf stage increased female flowers and suppressed male flowers in bitter gourd cv. Karela.

Female Flower Initiation

The maximum days to female flower initiation was recorded in the variety TMRG-1509 control Treatment (44.33) followed by NAA 200 ppm (44.13) and minimum was recorded by variety Aneeta with Treatment
GA3 200 ppm (37.67). Certain growth regulating chemicals viz., NAA, GA3 and 2,4-D have been reported to influence sex expression in various cucurbits, leading to either suppression of male flowers or an enhancement in the number of female flowers. Similar findings are reported by (Dashora and Jain, 1994) [29].

Fruit Yield Per Vine

The maximum fruit yield per Vine was recorded in the variety Aneeta with Treatment Ethrel 200 ppm (2.23kg) and Minimum was recorded in variety TMRG- 1509 (1.17 Kg) control Treatment. The increase in no. of fruit set per plant might probably due to the treatment which suppressed male flower production and promoted female flower production, ultimately higher numbers of fruits per plant were harvested. The results are in conformity with the findings of Kumar and Rao (2019) [1] who have recorded foliar spray of ethel 100 ppm and NAA 100 ppm increased number of fruit per plant in ridge gourd. Similar findings are found in Singh and Choudhary (2014) [6].

Quality parameters

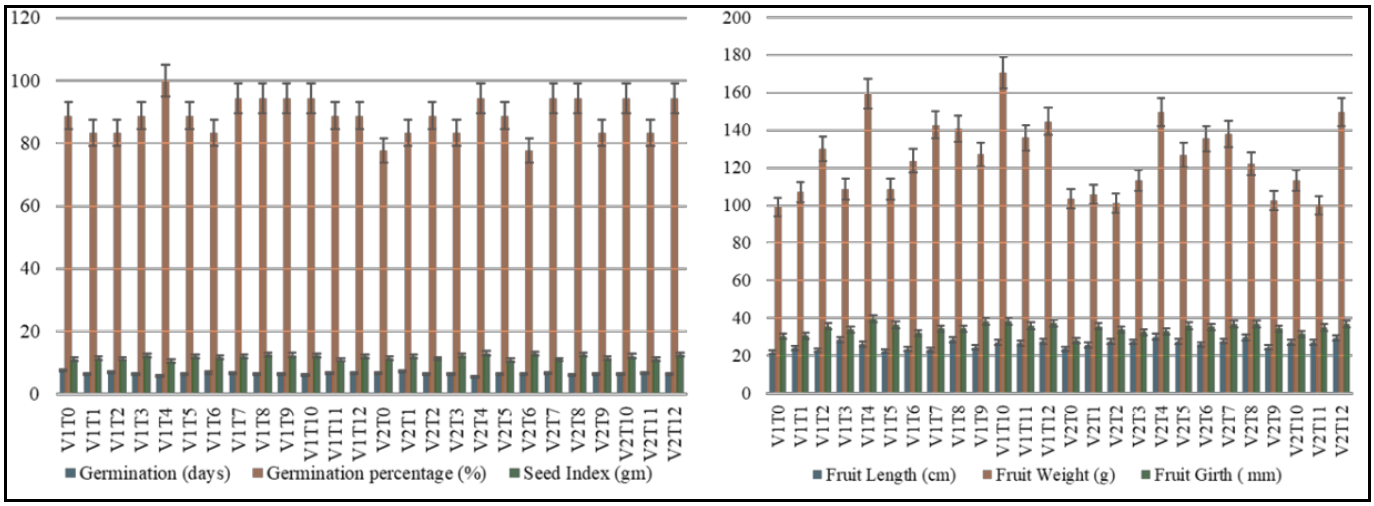
Total soluble solid

The Maximum TSS was recorded in the variety Aneeta with Treatment GA3 200 ppm (1.43) followed by Variety TMRG with Treatment NAA 200 ppm (1.42) and Minimum was recorded in Aneeta control Treatment (1.24). The increase in TSS. In the fruits seems probably due to accumulation of metabolites which stimulated functioning of a number of enzymes in physiological process. Which turns, hydrolized starch and helped in the metabolic activity during the change of available starch into sugar and T.S.S. Similar findings was reported Randhawa (1974) [34] in muskmelon.

Ascorbic Acid: The Maximum Ascorbic Acid was recorded in the variety Aneeta with Treatment GA3 200 ppm (11.23) followed by variety TMRG- 1509 with Treatment NAA 150 ppm (11.20) and Minimum was recorded in the variety Aneeta with Treatment NAA 50 ppm (9.50). Plant growth regulators can stimulate metabolic pathways involved in the synthesis of various compounds, including ascorbic acid. They can enhance enzyme activity and gene expression related to the biosynthesis of ascorbic acid, leading to its increased production.

Table 1: Performance of Ridge gourd (Luffa acutangula) for different dose of Plant growth regulators.

Treatments	Germination (days)	Seed Index (g)	Fruit Length (cm)	Fruit Weight (g)	Fruit Girth (mm)	Male flower initiation (Days)	Female flower initiation (Days)	Total Soluble Solid (Brix)	Ascorbic Acid (mg)	Fruit Yield per Vine (Kg)
$V1T_0$	7.45	11.07	21.67	99.17	30.33	34.33	41	1.26	9.77	1.22
$V1T_1$	6.45	11.47	24.13	107.13	30.67	33.33	40.33	1.31	10.57	1.36
$V1T_2$	6.89	11.23	22.90	130.33	35.67	33.00	40.00	1.30	10.73	1.71
$V1T_3$	6.44	12.27	28.47	108.63	34.00	35.00	42.00	1.34	10.87	1.52
$V1T_4$	5.78	10.53	26.27	159.47	39.67	30.67	37.67	1.43	11.23	1.77
$V1T_5$	6.22	12.03	22.23	108.63	36.33	34.00	41.33	1.28	10.50	1.41
$V1T_6$	6.78	11.67	23.40	123.77	32.00	35.00	42.00	1.34	10.87	1.55
$V1T_7$	6.67	11.93	23.33	142.93	34.33	34.33	41.33	1.28	11.20	1.75
$V1T_8$	6.22	12.47	28.30	140.97	34.33	36.33	43.33	1.42	10.27	1.72
$V1T_9$	6.44	12.43	24.43	127.10	38.33	33.67	40.67	1.35	10.53	1.57
$V1T_{10}$	6.11	12.20	27.27	170.63	38.33	34.67	41.67	1.28	10.40	1.97
$V1T_{11}$	6.67	10.93	26.67	136.10	36.00	33.00	40.00	1.38	10.67	1.68
$V1T_{12}$	6.56	11.87	27.60	144.77	37.33	34.00	41.00	1.33	10.47	2.23
$V2T_0$	6.66	11.43	23.67	103.47	28.00	37.67	44.33	1.24	10.47	1.17
$V2T_1$	7.22	11.93	25.63	105.83	35.67	34.33	42.33	1.29	10.40	1.17
$V2T_2$	6.44	11.27	27.67	101.23	34.00	32.00	39.00	1.28	10.10	1.24
$V2T_3$	6.33	12.33	27.33	113.40	32.67	35.00	42.00	1.36	10.43	1.46
$V2T_4$	5.45	13.00	30.03	149.50	33.00	33.00	41.00	1.30	11.00	1.91
$V2T_5$	6.45	10.87	27.43	126.90	36.00	33.00	40.00	1.34	9.50	1.49
$V2T_6$	6.34	12.80	25.93	135.67	35.33	35.33	42.33	1.27	10.23	1.63
$V2T_7$	6.56	10.97	27.77	138	36.67	31.33	38.33	1.35	10.13	1.63
$V2T_8$	6.00	12.53	29.67	122.27	36.67	37.33	44.13	1.27	10.63	1.28
$V2T_9$	6.44	11.40	24.37	102.50	34.33	35.33	42.33	1.28	10.27	1.39
$V2T_{10}$	6.44	12.13	27.27	113.47	31.67	33.33	40.33	1.29	10.40	1.39
$V2T_{11}$	6.55	11.13	26.97	100.10	35.00	33.33	40.33	1.30	9.90	1.20
$V2T_{12}$	6.22	12.60	29.47	149.63	37	36.33	44.00	1.27	10.67	1.98
S.E.	0.603	0.965	2.097	29.865	3.731	2.549	2.542	0.069	0.872	0.105
C.D.	1.212	1.940	4.213	59.962	7.494	5.121	5.105	0.140	1.751	0.211



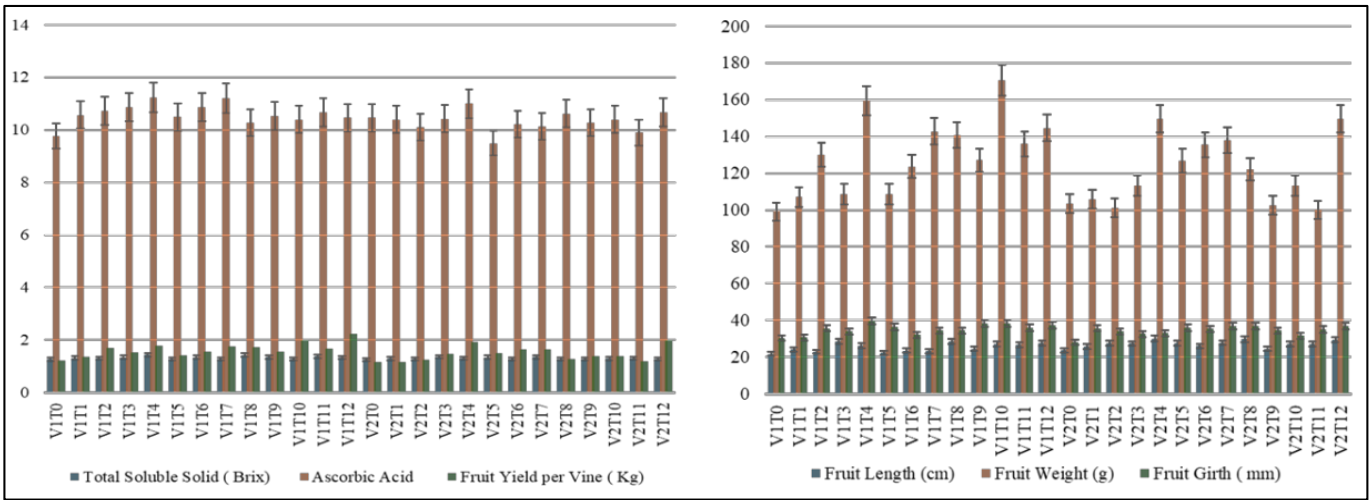


Fig 1: Performance of Ridge gourd (Luffa acutangula) for different dose of Plant growth regulators

Conclusion

From the present investigation, it was concluded that the influence of Plant growth Regulator with different combinations played their significant effect on, growth, yield and quality of Ridge gourd. Variety Aneeta and treatment GA3 200 ppm was recorded best in Vine length, Fruit per vine, average fruit weight, fruit girth, No. of fruit per plant, TSS, Ascorbic Acid, Yield per Vine with Net Return of (Rs. 494032.5) with Benefit Cost Ratio (3.92).

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