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Effect of plant growth regulators on growth parameters of papaya (*Carica papaya* L.) cv. Red Lady

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Abstract

A field experiment was conducted during 2024-25 at Agriculture Research and Development Centre, Sakatpura, School of Agriculture Science, Vikrant University, Gwalior, Madhya Pradesh to study the influence of gibberellic acid (GA₃) and naphthalene acetic acid (NAA) on vegetative growth of papaya (*Carica papaya* L.) cv. Red Lady. The experiment was laid out in a randomized block design with seven treatments and three replications. The treatments included water spray, GA₃ at 75 and 150 ppm, NAA at 50 and 100 ppm, and two combined treatments of GA₃ + NAA. Growth observations were recorded for plant height, stem girth, number of leaves per plant and canopy spread at different crop stages. The treatment T₇ (GA₃ @ 150 ppm + NAA @ 100 ppm) recorded the maximum plant height (177.8 cm), stem girth (18.72 cm), number of leaves per plant (52.4) and canopy spread (204.4 cm) at first flowering. It remained statistically at par with T₆ (GA₃ @ 75 ppm + NAA @ 50 ppm) for most observations, but both combined treatments were distinctly superior to the control. The results showed that balanced use of GA₃ and NAA improved vegetative vigour of papaya through better cell elongation, leaf production and canopy development under the Gird agro-climatic zone of Madhya Pradesh.

Keywords: Papaya, Red Lady, GA₃, NAA, plant height, stem girth, canopy spread, growth parameters

Introduction

Papaya (*Carica papaya* L.) is an important tropical fruit crop valued for its early bearing habit, year-round fruiting potential, nutritive pulp and wide adaptability under irrigated horticultural systems. The hybrid Red Lady has gained commercial preference because of its uniform plant stand, attractive fruit shape and acceptable eating quality. For profitable papaya cultivation, early vegetative vigour is important because plant height, stem girth, leaf number and canopy expansion directly influence photosynthetic capacity, flowering behaviour and subsequent fruit development.

Plant growth regulators are commonly used in fruit crops to regulate growth, flowering and fruiting. Gibberellic acid promotes cell division and cell elongation, while NAA helps in hormonal balance, assimilate movement and reduction of fruit drop. Earlier studies in papaya have shown that plant growth regulators can significantly influence plant height, girth, canopy spread, fruiting and quality attributes (Hazarika *et al.*, 2016; Maurya *et al.*, 2025) [7, 10]. Similar responses have also been reported in other fruit crops where GA₃ and NAA improved fruit retention, yield and quality (Nkansah *et al.*, 2012) [12]. The response of papaya to growth regulators may vary with cultivar, stage of application, concentration and growing environment. Therefore, the present study was undertaken to assess the effect of different concentrations of GA₃ and NAA, applied alone and in combination, on the growth parameters of papaya cv. Red Lady under the Gird agro-climatic zone of Madhya Pradesh. Materials and Methods: Experimental site and crop, The field experiment was carried out during 2024-25 at Agriculture Research and Development Centre, Sakatpura, School of Agriculture Science, Vikrant University, Gwalior, Madhya Pradesh. The experimental area falls under a semi-arid to subtropical climate with hot summers, moderate monsoon rainfall and comparatively cool winters. The soil of the experimental field was sandy loam to clay loam in texture, well drained and slightly alkaline in reaction. Experimental design, treatments and crop management.

The experiment was arranged in randomized block design with seven treatments and three replications. Papaya cv. Red Lady seedlings were transplanted at a spacing of 1.8 m × 1.8 m. Each plot measured 3.6 m × 3.6 m and contained four plants. GA₃ and NAA solutions were prepared at the required concentrations and applied as foliar spray at pre-flowering and fruit set stages. Uniform cultural practices including irrigation, weeding, earthing up and plant protection measures were followed in all plots. Observations and statistical analysis: Observations on plant height, stem girth and number of leaves per plant were recorded at 30, 60, 90, 120 DAT and at first flowering. Canopy spread was recorded at 60, 90, 120 DAT and at first flowering. The recorded data were statistically analyzed according to the procedure of randomized block design. Treatment means were compared using critical difference at 5% level of

significance wherever the F-test was significant (Gomez and Gomez, 1984) [6]. Results and Discussion: Effect on plant height Plant height increased progressively with crop age and was significantly influenced by growth regulator treatments from 60 DAT onwards. At 30 DAT, the treatment effect was non-significant, although T₇ recorded the numerically highest value (48.9 cm). At first flowering, T₇ recorded the maximum plant height (177.8 cm), which remained statistically at par with T₆ (168.4 cm) and was superior to the remaining treatments. The lowest plant height was observed under T₁-control: water spray (126.4 cm). The improved plant height under combined GA₃ and NAA may be attributed to enhanced cell division and elongation, better nutrient movement and improved vegetative activity.

Table 1: Effect of plant growth regulators on plant height (cm) of papaya cv. Red Lady.

SL	Treatment	30 DAT	60 DAT	90 DAT	120 DAT	At first flowering
1.	T ₁	45.7	61.2	78.4	103.5	126.4
2.	T ₂	46.4	65.4	84.8	112.8	136.2
3.	T ₃	47.2	68.1	95.6	125.7	148.6
4.	T ₄	46.1	64.2	82.5	109.4	132.8
5.	T ₅	46.8	66.5	90.8	119.6	142.4
6.	T ₆	48.1	75.6	112.3	143.5	168.4
7.	T ₇	48.9	79.2	119.6	151.2	177.8
8.	S.E.m.±	2.55	3.21	4.44	5.78	6.90
9.	CD (P = 0.05)	N.S.	9.89	13.67	17.82	21.26
10.	CV (%)	9.40	8.10	8.10	8.10	8.10

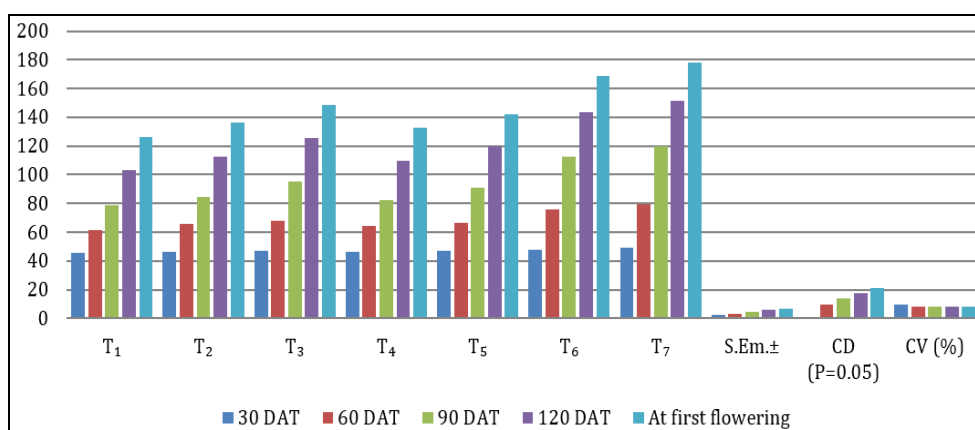


Fig 1: Effect of plant growth regulators on plant height (cm) of papaya cv. Red Lady

Effect on stem girth: Stem girth followed a trend similar to plant height. At 30 DAT, the differences were non-significant, whereas significant variation was observed at 60, 90, 120 DAT and at first flowering. The maximum stem girth at first flowering was recorded in T₇ (18.72 cm), which

was statistically at par with T₆ (17.64 cm). The minimum value was recorded in the control (11.84 cm). The thicker stem under combined growth regulator treatments indicates better structural growth and greater assimilate accumulation.

Table 2: Effect of plant growth regulators on stem girth (cm) of papaya cv. Red Lady.

SL	Treatment	30 DAT	60 DAT	90 DAT	120 DAT	At first flowering
1.	T ₁	4.82	6.18	8.05	10.42	11.84
2.	T ₂	4.90	6.66	8.96	11.52	13.18
3.	T ₃	5.04	7.20	9.92	12.82	14.82
4.	T ₄	4.87	6.48	8.62	11.12	12.62
5.	T ₅	4.96	6.92	9.34	12.06	13.88
6.	T ₆	5.18	8.36	11.72	15.28	17.64
7.	T ₇	5.26	8.82	12.44	16.12	18.72
8.	S.E.m.±	0.27	0.35	0.47	0.60	0.69
9.	CD (P = 0.05)	N.S.	1.08	1.46	1.86	2.11
10.	CV (%)	9.20	8.40	8.30	8.20	8.10

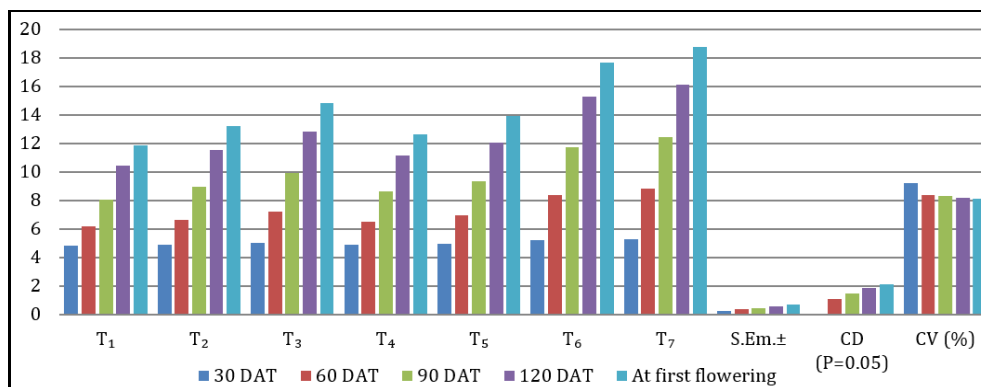


Fig 2: Effect of plant growth regulators on stem girth (cm) of papaya cv. Red Lady

Effect on number of leaves per plant and canopy spread

Leaf production and canopy spread are important indicators of photosynthetic surface in papaya. The maximum number of leaves per plant at first flowering was recorded under T₇ (52.4), followed by T₆ (48.6), while the control recorded the minimum value (31.2). Canopy spread also increased with growth regulator application. At first flowering, T₇ recorded the highest canopy spread (204.4 cm), which remained at par with T₆ (191.6 cm). Better leaf production and canopy expansion under combined treatments could be due to improved physiological activity and increased assimilate production. Hazarika *et al.* (2016) [7] also reported higher vegetative growth in papaya cv. Red Lady under growth regulator application.

Table 3: Effect of plant growth regulators on number of leaves per plant of papaya cv. Red Lady.

SL	Treatment	30 DAT	60 DAT	90 DAT	120 DAT	At first flowering
1.	T ₁	11.8	16.4	21.8	27.6	31.2
2.	T ₂	12.1	18.0	24.3	30.8	34.8
3.	T ₃	12.4	19.6	27.8	34.6	39.2
4.	T ₄	12.0	17.4	23.4	29.4	33.6
5.	T ₅	12.3	18.9	26.1	32.8	37.2
6.	T ₆	12.8	22.8	34.2	42.4	48.6
7.	T ₇	13.1	24.2	36.8	45.6	52.4
8.	S.E.m.±	0.66	0.95	1.33	1.64	1.85
9.	CD (P = 0.05)	N.S.	2.93	4.10	5.07	5.70
10.	CV (%)	9.30	8.40	8.30	8.20	8.10

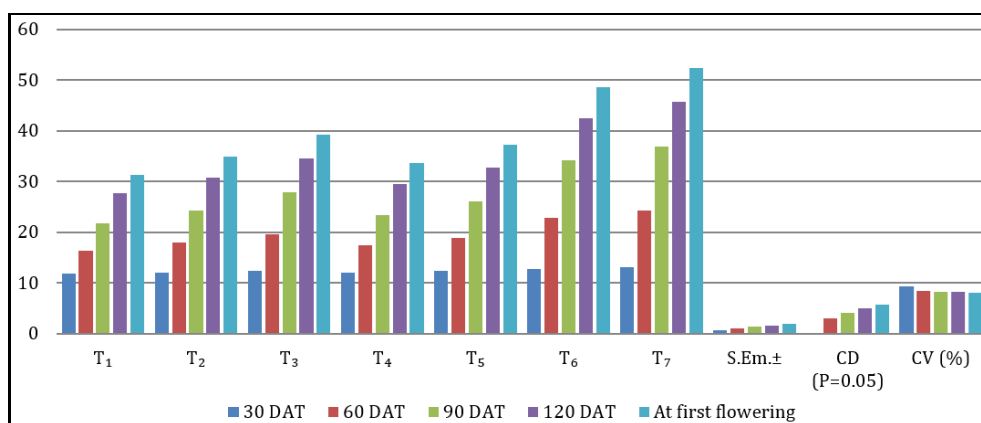
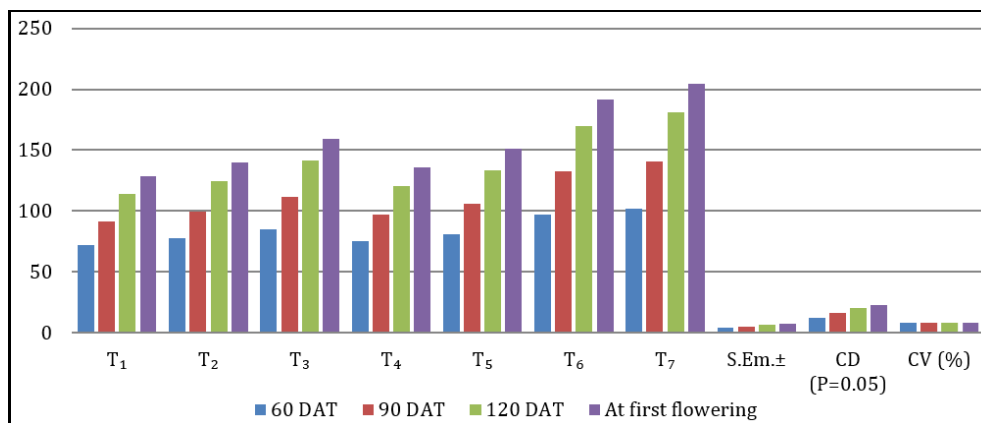


Fig 3: Effect of plant growth regulators on number of leaves per plant of papaya cv. Red Lady.

Table 4: Effect of plant growth regulators on canopy spread (cm) of papaya cv. Red Lady.

SL	Treatment	60 DAT	90 DAT	120 DAT	At first flowering
1.	T ₁	72.4	91.6	113.8	128.4
2.	T ₂	77.8	99.5	124.2	139.6
3.	T ₃	84.6	111.4	141.8	159.4
4.	T ₄	75.6	96.8	120.6	135.8
5.	T ₅	81.2	105.8	133.6	150.8
6.	T ₆	96.8	132.6	169.4	191.6
7.	T ₇	101.6	140.8	181.2	204.4
8.	S.E.m.±	4.04	5.27	6.58	7.42
9.	CD (P = 0.05)	12.45	16.23	20.27	22.85
10.	CV (%)	8.30	8.20	8.10	8.10

DAT = days after transplanting; N.S. = non-significant; S.E.m.± = standard error of mean; CD = critical difference at 5% level.



DAT = days after transplanting; N.S. = non-significant; S.E.m.± = standard error of mean; CD = critical difference at 5% level.

Fig 4: Effect of plant growth regulators on canopy spread (cm) of papaya cv. Red Lady.

Conclusion

The results clearly indicated that combined foliar application of GA₃ and NAA improved growth performance of papaya cv. Red Lady. Among the treatments, T₇ (GA₃ @ 150 ppm + NAA @ 100 ppm) produced the highest plant height, stem girth, number of leaves and canopy spread, followed by T₆ (GA₃ @ 75 ppm + NAA @ 50 ppm). The superiority of combined treatments may be due to favorable hormonal balance and enhanced vegetative growth. On the basis of one-season results, T₇ may be considered the most effective treatment for improving vegetative growth of papaya under the Gwalior region, subject to further multi-season validation.

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