

Effect of Growth Regulators on Seed Germination and Seedling Growth Index of Radish (*Raphanus sativus* L.) cv Japanese White

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Abstract The study was carried out to explore the effect of growth regulators on seed germination and seedling growth index of radish (*Raphanus sativus* L.) cv Japanese white. The growth regulators Gibberellic Acid and Indole Acetic Acid (GA₃ and IAA) were used at different concentrations. The experiment was laid out in completely randomized design, with six treatment combinations (Control, IAA 50 and 100 ppm, GA₃ 50 and 100 ppm and GA₃ + IAA 50 ppm each) and four replicated. The control seeds were sown with distil water. All the treatment significantly increased germination percentage, germination index, seedling length (cm), seedling fresh weight (g), root fresh weight (g), shoot fresh weight (g), shoot dry weight (g), vigor index I (cm) and II (g). The best treatment was found to be T₆ treatment GA₃ + IAA 50 ppm each.

Keywords Radish, Growth regulator, Seed germination, Seedling vigor, Growth index.

Introduction

Radish (*Raphanus sativus* L.) is the most important root crop cultivated in India and high value nutritive root crop containing 15-40 mg/100 g of edible portion and supplies a variety of minerals and vitamins. Japanese white is an Asiatic variety, which matures in 40-45 days. The roots are cylindrical, stumpy and about 20-30 cm long. The skin is pure white smooth and the flesh is snow white, crisp, solid, sweet and mildly pungent, top medium large with deeply cut leaves. The roots grow better when the temperature is low. Roots are free from bolting, pithness and forking. The radish (*Raphanus raphanistrum* subsp. *sativus*) is an edible root vegetable of the Brassicaceae family that was domesticated in Europe in pre-Roman times. Radishes are grown and consumed throughout the world, being mostly eaten raw as a crunchy salad vegetable. They have numerous varieties, varying in size, flavor, color and length of time they take to mature. Radishes owe their sharp flavor to the various chemical compounds produced by the plants, including glucosinolate, myrosinase and isothiocyanate.

Radish is a quick growing cool season root vegetable. The seed will germinate in 3 to 4 days with soil temperatures of 18 to 30 C with good moisture. The minimum temperature for germination is 5°C, the optimum temperature for germination is 30°C. The maximum temperature for germination is 35°C. Germination rates decline sharply when the soil temperature falls below 13°C. The best quality and root shape are obtained when the crop grows and matures

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at moderate temperature (10 to 18°C) in intermediate to short day lengths. Radish remain in prime condition for only a few days.

The growth regulators are used in different ways but generally seed treatment is adopted. Seed treatment is suitable method for radish crop (ISTA 1976).

Materials and Methods

The trial on effect of plant growth regulators on growth and yield of radish (*Raphanus sativus* L.) cv Japanese white was conducted in lab condition of Dehradun region. The present investigation was carried out at the Horticulture lab, Uttaranchal (PG) College of Bio-Medical Sciences and Hospital, Dehradun during the winter season of 2018. The experiment was laid out in Horticulture lab, Uttaranchal (PG) College of Bio-Medical Sciences and Hospital, Dehradun (Uttarakhand). The seeds of radish were collected from private nursery, Dehradun during Feb 22, 2018. The experiment was laid out in completely randomized design with four replications. Each replication consisted of six treatments.

Germination studies were conducted in petri dish. Aqueous solutions (50 ppm and 100 ppm) of different growth regulators IAA and GA₃ was prepared separately control was also maintained in parallel with treated material. The seeds were soaked in different growth regulators with 50 ppm and 100 ppm concentration for 10 to 15 minutes at 15-20°C before sowing. Likewise various concentrations of GA₃ i.e. 50 and 100 ppm was also used. Seeds were sown in the petri dish containing mixture of distilled water and growth regulator. For each treatment 10 seeds were taken. The experiment was conducted in total darkness and light 10 to 12 h. Observations were recorded daily for germination, speed of germination, germination percent, number of days required for germination, seedling length (cm), root length (cm), shoot length (cm), shoot fresh weight (g), root fresh weight (g), shoot dry weight (g) and root dry weight. Germination percentage was calculated. The rate of germination was calculated by using the formula suggested by Maguire (1962). The vigor index was calculated in two ways by considering both length of

the seedlings (Vigor index I) and dry weight of the seedling along with per cent germination (Vigor index II) (Abdul and Anderson 1973, Waes and Deburg 1986, Baloch 1994).

The seedling vigor index was calculated by following the formula and represented in tabular and graphical form.

$$\text{Vigor index I (cm)} = \frac{\text{Seedling length (shoot length + root length)}}{\times \text{per cent germination}}$$

$$\text{Vigor index II (g)} = \frac{\text{Dry weight of seedling} \times \text{per cent germination}}$$

Percentage of germination was calculated by the following formula :

$$\text{Germination percentage} = \frac{\text{Number of seeds germinated}}{\text{Total number of seed sown}} \times 100$$

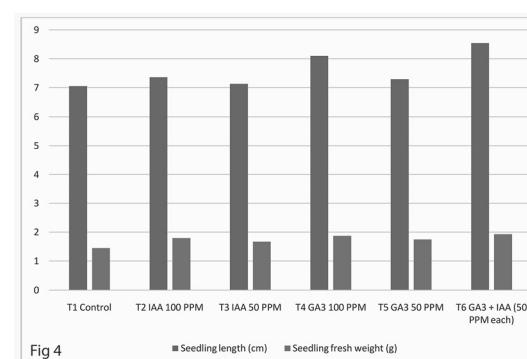
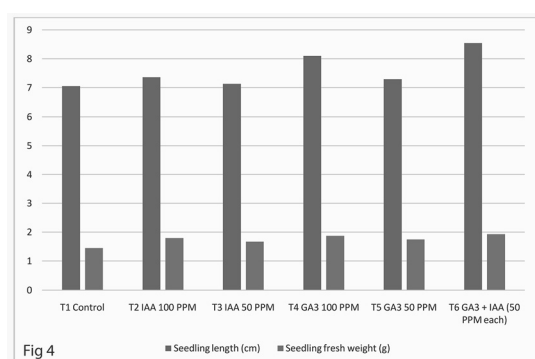
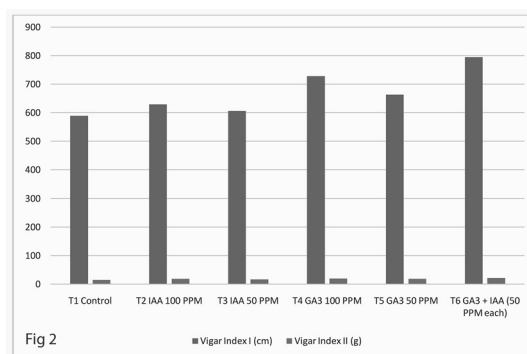
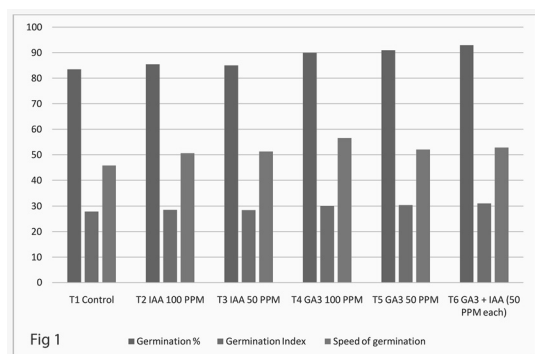
Germination index was calculated as described in the Association of Official Seed Analysis (1983) using the following formula :

$$\text{Germination index} = \frac{\text{No. of germinating seeds}}{\text{Days of first count}} + \frac{\text{No. of germinating seeds}}{\text{Days of final or last count}}$$

Germination value (GV) was calculated according to Hossain et al. (2005) following the formula :

$$\text{Germination value} = (\Sigma \text{DGs}/N) \times \text{GP}/10$$

Where, GP is the germination percentage at the end of experiment, DG is the daily germination speed obtained by dividing cumulative germination percentage by the number of days since sowing, Σ DGs is the total germination obtained by adding every value of DG obtained from daily counts, N is the total number of daily counts, starting from the first germination and (10) is a constant. Four replicates of 50 seeds were used for each treatment, observations were recorded daily for the seed germination. Shoot length, root length and germination percentage were calculated. All the observations were recorded after 2 weeks.



Figs. 1, 2, 3 and 4. Effect of growth regulators on seed germination and seedling growth index of radish.

Results and Discussion

Results showed that growth regulators GA₃ and NAA had a beneficial effect on seed germination and seedling growth in of radish (*Raphanus sativus* L.) cv Japanese white.

Seed germination

Seed germination parameters in radish as affected by growth regulators GA₃ 50 ppm + IAA 50 ppm are presented in Table 1, Figs.1—4. Treatment T₆ was found to be the best, followed by T₅ GA₃ 50 ppm as for germination parameters. The germination percentage of GA₃ 50 ppm+ IAA 50 ppm was 93.00% followed by T₅ GA₃ 50 ppm 86.50%.

Seedling growth and development

Data presented show significant increase in seedling

growth of radish as affected by combination of different growth regulators GA₃ 50 ppm + IAA 50 ppm. Maximum length of seedling was observed in T₆ GA₃ 50 ppm + IAA 50 ppm (8.55 cm) which was at par with T₄ GA₃ 100 ppm (8.09 cm). Maximum fresh weight of shoot T₆ GA₃ 50 ppm + IAA 50 ppm (1.33g) were recorded in T₆ treatment. Similarly, maximum fresh weight of roots wear recorded in T₆ GA₃ 50 ppm + IAA 50 ppm (0.58g).

Conclusion

From the above data it may be concluded that growth hormones gave better response over control. Amongst all growth hormones, GA₃ 50 ppm + IAA 50 ppm gave best response for seed germination, seedling growth and development. GA₃ increases germination percent from 50 to 60 ppm but over 60 ppm concentration, germination decreases rapidly during light and dark

Table 1. Effect of growth regulators on seed germination and seedling growth index of radish.

Treatments	Germination %	Germination index	Seedling length (cm)	Seedling		Vigor index I (cm)	Vigor index II (g)	Root fresh weight (g)	Shoot fresh weight (g)	Root dry weight (g)	Shoot dry weight (g)
				fresh weight (g)	Speed of germination						
T ₁ Control	83.50	27.83	7.05	1.45	45.76	588.74	14.17	0.49	0.97	0.064	0.106
T ₂ IAA 100	85.50	28.50	7.36	1.79	50.66	629.17	17.78	0.54	1.25	0.070	0.138
T ₃ TAA 50 ppm	85.00	28.33	7.13	1.67	51.27	606.16	16.50	0.52	1.15	0.068	0.127
T ₄ GA ₃ 100 ppm	90.00	30.00	8.10	1.87	56.54	728.34	19.52	0.57	1.30	0.074	0.143
T ₅ GA ₃ 50 ppm	91.00	30.33	7.29	1.74	52.01	663.38	18.34	0.54	1.20	0.070	0.132
T ₆ GA ₃ IAA (50 ppm each)	93.00	31.00	8.55	1.93	52.85	795.24	20.76	0.58	1.35	0.076	0.148
CD	4.601	1.520	0.269	0.074	4.374	41.809	1.660	0.052	0.060	0.061	0.007
SE (m)	1.537	0.508	0.090	0.025	2.407	13.963	0.555	0.018	0.020	0.003	0.002
SE(d)	2.173	0.718	0.127	0.035	3.404	19.747	0.784	0.025	0.028	0.005	0.003
CV	3.492	3.459	2.371	2.834	5.344	4.177	6.216	6.509	3.351	4.876	3.343

period. The treatment of GA₃ was effective in breaking seed dormancy and reaching the germination rate and high vigor index.

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