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Effect of seaweed extract and humic acid on yield parameters of red radish

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Abstract
A field experiment was conducted at the Pt. K.L.S. College of Horticulture and Research Station, Rajnandgaon (C.G.), during Rabi season of 2020-21, to evaluate the "Influence of foliar spray with seaweed extract and humic acid on growth, yield and quality of red radish". Totally seven different treatments and 03 replication with three experiments consisting of different growth regulators foliar spray have been tried. Among the effect of different plant growth regulators foliar spray practices, the yield parameters *viz.* Yield t/ha. (Leaves) and Yield t/ha. (Roots) of Distilled water soaked seeds, Seaweed soaked seeds and Humic acid soaked seeds were significantly superior in the treatment T_6 (3ml/L Humic acid foliar spray (95%)). However, treatment T_3 (3ml/L Seaweed extract foliar spray (20%)), comes in next in order. There for it may be concluded that treatment T_6 (3ml/L Humic acid foliar spray (95%)) of Humic acid soaked seeds, may be prefer for higher growth, quality and yield in red radish.

Keywords: Seaweed, humic, parameters, red radish

Introduction
The Red radish (*Raphanus sativus* L.) is grown mainly for its root; A small, scarlet globe with a crisp and peppery, translucent, white flesh. Their roots range in diameter from one to three inches. The radish produces green leaves that grow from the root above ground, which are also edible. They have the texture of watercress and a bit of its flavor, but with a great mustardy bite as well. Red radishes, also known as table radishes, are a popular cultivar of Raphanus sativus and a member of the Brassicaceae family. There are literally dozens of varieties of this cruciferous root vegetable, including annuals with crispy round and elongated taproots in a variety of hues. Some of the most popular varieties include cherry belle, crimson giant, and scarlet globe. Red radishes contain vitamin C, foliate, fiber and potassium. Like many radishes, Red radishes contain active enzymes that are known to aid in digestion. Radishes count as one of the earliest garden vegetables, and are among the easiest to grow. The "hotness" of radishes results from the length of time they have grown. Radishes that grow too slowly, are heat and moisture stressed, or are very old are often "hot." Old radishes will also generally split, so it is best to harvest them when they are younger.

Radish is a popular root vegetable in temperate to tropical regions. It is a favorable crop of the kitchen gardeners because it is easily grown and is ready for use in 3 to 6 weeks after sowing. It is cultivated under glass house for early and multi-cropping production but the large scale production in the field is more common. Radish is cultivated throughout Punjab, Maharashtra, Uttar Pradesh and Kashmir and Gujarat. In Chhattisgarh, Kondagaon, Korba, Surguja, Kanker, Durg, Rajnandgaon, Raipur and Korea are particularly important radish producing districts.

Radish is a short duration crop, can be grown nearly on all types of soils, but the best results are obtained on light, friable loam soils containing ample humus. Sandy or sandy loam soils are preferred for early crops; however, for summer crops a cool, moist soil gives the best result. Radish is best adapted to cool or moderate climate. The Asian cultivars with greater temperature adaptations can resist heat more conveniently than the European cultivars.

Radish is very important in human diet as it possess high nutritive value. The edible portion is the enlarged root which is rich in carbohydrate and also contains minerals and vitamin. According to Tindal (1983) the nutritive value of radish root per 100 g of edible portion each and under: water (94.00 ml), calories (18.00), protein (1.00 g), fat (0.10 g), fiber (0.70 g), iron (1.00 mg), carbohydrate (4.00 g), calcium (3.00 mg), phosphorous (30.00 mg), thiamine (0.30 mg), riboflavin (0.30 mg), ascorbic acid (25.00 mg) and radish leaves per 100 g of edible

portion is an under: water (88.00 ml), calories (33.00), protein (3.30), fat (0.60), carbohydrate (6.00), fiber (1.10), phosphorous (30.00), iron (4.10), thiamine (0.08), riboflavin (0.28), ascorbic acid (81.00).

Seaweed extracts contain natural plant growth regulators (PGR) such as auxins and cytokinins which control the growth and structural development of plants. The PGRs in seaweed are present in very small quantities in the level of parts per million. However, the Indole compounds present in the seaweed extract helps in the development of roots and buds and cytokinins promote plant growth. When it is applied to foliage, the leaves rejuvenate stimulating photosynthesis. So, Seaweed extract with formulation results in higher yield.

Humic acids also promote antioxidant production in plants which in turn reduce free Radicals, which result from stress (drought, heat and ultraviolet light). There radicals are damaging because they are strong oxidizing agents which damage lipids, proteins and DNA within plants cells. Antioxidants are metabolites and enzymes which seek out free radical molecules and protect plants from damage. They include lipid soluble substances like vitamin E, beta-carotene and water soluble materials such as vitamin C and various enzymes.

Materials and Methods

The present investigation entitled "Influence of foliar spray with Seaweed extract and humic acid on growth, yield and quality of red radish" was conducted during *Rabi* season of 2020-21 at college Field, under Pt. K.L.S. College of Horticulture and Research Station Pendri, Rajnandgaon, (C.G.). Rajnandgaon comes under the geographical area of western part of Chhattisgarh with latitude 21.10° N, and longitude 81.03° E and an altitude of 330.70 meters above the mean sea level. Rajnandgaon is located in west central agro climatic Zone of Chhattisgarh with tropical wet and dry climate which has extreme winter and moderate summer. This region generally receives monsoon during June-October with mean annual precipitation of 1274 mm. The maximum temperature at Rajnandgaon goes upto 47 °C in summer season while minimum temperature falls down upto 12 °C in winter season.

The experiment consisted of 7 treatments *viz*. T_1: 1ml/L Seaweed extract foliar spray (20%), T_2: 2ml/L Seaweed extract foliar spray (20%), T_3: 3ml/L Seaweed extract foliar spray (20%), T_4: 1ml/L Humic acid foliar spray (95%), T_5: 2ml/L Humic acid foliar spray (95%), T_6: 3ml/L Humic acid foliar spray (95%), T_0: Control which was arranged in Randomized Block Design with three replications. The complete dose of phosphatic and potassic fertilizers and half dose of urea were applied in rows before sowing the seeds, whereas the remaining dose of urea was given by top dressing in two split doses after 15 and 30 days of sowing. The seeds were mixed with sand and sown in ridge and furrow system at a depth of 1.5 cm in rows as per the treatment. The field was irrigated immediately after sowing, by taking utmost care so that the seeds were not disturbed with flow of water. The experimental plot was kept weed free throughout the crop growth period with supplementary hand weeding and hoeing. Necessary plant protection measures were adopted to control the pests and diseases during the crop growth period. Harvesting was done by pulling the roots after attaining maturity. Light irrigation was given one day before harvesting for easy lifting of roots. The roots were washed to remove the adhering soil particles before taking the observations on various root characteristics.

Results and Discussion

(A) Yield t/ha. (Leaves) and Yield t/ha. (Roots)

The data on various yield attributes *viz*. yield t/ha. (Leaves) and yield t/ha. (Roots) as influenced by the nutrient management practices were recorded and presented in Table 1, 2 and figure 1, 2. The data revealed that the yield t/ha. (Leaves) of Distilled water soaked seeds in relation to growth parameter treatment was found to be significant. Treatment T_6, (3ml/L Humic acid foliar spray (95%)) recorded significantly highest yield t/ha. (Leaves) (13.22), at par with the treatment T_5 (2ml/L Humic acid foliar spray (95%)) (12.30) and T_3 (3ml/L Seaweed extract foliar spray (20%)) (12.10). The lowest yield t/ha. (Leaves) performed (10.20) were recorded in the treatment T_0 (Control).

The data revealed that the yield t/ha. (Leaves) of Seaweed soaked seeds in relation to growth parameter treatment was found to be significant. Treatment T_6, (3ml/L Humic acid foliar spray (95%)) recorded significantly highest yield t/ha. (Leaves) (14.99), at par with the treatment T_5 (2ml/L Humic acid foliar spray (95%)) (12.63) and T_3 (3ml/L Seaweed extract foliar spray (20%)) (12.43). The lowest yield t/ha. (Leaves) performed (10.74) were recorded in the treatment T_0 (Control).

The data revealed that the yield t/ha. (Leaves) of Humic acid soaked seeds in relation to growth parameter treatment was found to be significant. Treatment T_6, (3ml/L Humic acid foliar spray (95%)) recorded significantly highest yield t/ha. (Leaves) (15.87), at par with the treatment T_5 (2ml/L Humic acid foliar spray (95%)) (13.97) and T_4 (1ml/L Humic acid foliar spray (95%) (13.67). The lowest yield t/ha. (Leaves) performed (10.77) were recorded in the treatment T_0 (Control).

Seaweed and humic acid have been reported to improve plant physiological processes by enhancing the availability of major and minor nutrients as well as enhancing the vitamins, amino acids, and also auxine, cytokinine and ABA contents of the plants. Thus, it enhances the uptake of essential nutrients and increases plant resistance to pests and diseases. The similer result was found by Mahorkar *et al.* (2008) [8] studied the effect of micronutrients and humic acid on the growth and leaf yield of fenugreek and reported that the treatment with Zn at 0.5%+Fe at 0.5%+humic acid at 0.05% exhibited the maximum value of all vegetative parameters, *i.e.* plant height, number of leaves per plant, number of branches per plant and leaf area per plant, as well as green leaf yield per plot and per hectare.

The data revealed that the yield t/ha. (Roots) of Distilled water soaked seeds in relation to growth parameter treatment was found to be significant. Treatment T_6, (3ml/L Humic acid foliar spray (95%)) recorded significantly highest yield t/ha. (Roots) (7.10), at par with the treatment T_5 (2ml/L Humic acid foliar spray (95%)) (6.68) and T_3 (3ml/L Seaweed extract foliar spray (20%)) (6.31). The lowest yield t/ha. (Roots) performed (4.70) were recorded in the treatment T_0 (Control).

The data revealed that the yield kg per plot (Roots) of Seaweed soaked seeds in relation to growth parameter treatment was found to be significant. Treatment T_6, (3ml/L Humic acid foliar spray (95%)) recorded significantly highest yield t/ha. (Roots) (7.93), at par with the treatment T_5 (2ml/L Humic acid foliar spray (95%)) (7.02) and T_3 (3ml/L Seaweed

extract foliar spray (20%)) (6.64). The lowest yield t/ha. (Roots) performed (4.68) were recorded in the treatment T_0 (Control).

The data revealed that the yield t/ha. (Roots) of Humic acid soaked seeds in relation to growth parameter treatment was found to be significant. Treatment T_6, (3ml/L Humic acid foliar spray (95%)) recorded significantly highest yield t/ha. (Roots) (8.57), at par with the treatment T_5 (2ml/L Humic acid foliar spray (95%)) (7.05) and T_3 (3ml/L Seaweed extract foliar spray (20%)) (6.97). The lowest yield yield t/ha. (Roots) performed (4.84) were recorded in the treatment T_0 (Control).

Seaweed and humic acid have been reported to improve plant physiological processes by enhancing the availability of major and minor nutrients as well as enhancing the vitamins, amino acids, and also auxine, cytokinine and ABA contents of the plants. Thus, it enhances the uptake of essential nutrients and increases plant resistance to pests and diseases. That also reflected in the increased yield t/ha. (Roots). Humic acids had a significant effect on root yield. The similer result was found by Mahorkar *et al.* (2008) [8].

(B) Yield kg/ha. (Leaves) and Yield kg/ plot. (Roots)

The data on various yield attributes *viz.* yield kg/ha. (Leaves) and Yield kg/plot (Roots) as influenced by the nutrient management practices were recorded and presented in Table 3 and 4 and figure 3 and 4. The data revealed that the yield kg per plot (Leaves) of Distilled water soaked seeds in relation to growth parameter treatment was found to be significant. Treatment T_6, (3ml/L Humic acid foliar spray (95%)) recorded significantly highest yield kg per plot (Leaves) (2.97), at par with the treatment T_5 (2ml/L Humic acid foliar spray (95%)) (2.77) and T_3 (3ml/L Seaweed extract foliar spray (20%)) (2.72). The lowest yield kg per plot (Leaves) performed (2.30) were recorded in the treatment T_0 (Control).

The data revealed that the yield kg per plot (Leaves) of Seaweed soaked seeds in relation to growth parameter treatment was found to be significant. Treatment T_6, (3ml/L Humic acid foliar spray (95%)) recorded significantly highest yield kg per plot (Leaves) (3.37), at par with the treatment T_5 (2ml/L Humic acid foliar spray (95%)) (2.84) and T_3 (3ml/L Seaweed extract foliar spray (20%)) (2.80). The lowest yield kg per plot (Leaves) performed (2.42) were recorded in the treatment T_0 (Control).

The data revealed that the yield kg per plot (Leaves) of Humic acid soaked seeds in relation to growth parameter treatment was found to be significant. Treatment T_6, (3ml/L Humic acid foliar spray (95%)) recorded significantly highest yield kg per plot (Leaves) (3.57), at par with the treatment T_5 (2ml/L Humic acid foliar spray (95%)) (3.14) and T_4 (1ml/L Humic acid foliar spray (95%)) (3.08). The lowest yield kg per plot (Leaves) performed (2.42) were recorded in the treatment T_0 (Control).

The data revealed that the yield kg per plot (Roots) of Distilled water soaked seeds in relation to growth parameter treatment was found to be significant. Treatment T_6, (3ml/L Humic acid foliar spray (95%)) recorded significantly highest yield kg per plot (Roots) (1.60), at par with the treatment T_5 (2ml/L Humic acid foliar spray (95%)) (1.50) and T_3 (3ml/L Seaweed extract foliar spray (20%)) (1.42). The lowest yield kg per plot (Roots) performed (1.06) were recorded in the treatment T_0 (Control).

The data revealed that the yield kg per plot (Roots) of Seaweed soaked seeds in relation to growth parameter treatment was found to be significant. Treatment T_6, (3ml/L Humic acid foliar spray (95%)) recorded significantly highest yield kg per plot (Roots) (1.78), at par with the treatment T_5 (2ml/L Humic acid foliar spray (95%)) (1.58) and T_3 (3ml/L Seaweed extract foliar spray (20%)) (1.49). The lowest yield kg per plot (Roots) performed (1.05) were recorded in the treatment T_0 (Control).

The data revealed that the yield kg per plot (Roots) of Humic acid soaked seeds in relation to growth parameter treatment was found to be significant. Treatment T_6, (3ml/L Humic acid foliar spray (95%)) recorded significantly highest yield kg per plot (Roots) (1.93), at par with the treatment T_5 (2ml/L Humic acid foliar spray (95%)) (1.59) and T_3 (3ml/L Seaweed extract foliar spray (20%)) (1.57). The lowest yield kg per plot. (Roots) performed (1.09) were recorded in the treatment T_0 (Control).

Table 1: Influence of foliar spray with Seaweed extract and humic acid on yield t/ha. (Leaves)

Yield t/ha. (Leaves)					
S. No.	**Tr. No.**	**Treatment Details**	**Distilled water soaked seeds**	**Seaweed soaked seeds**	**Humic acid soaked seeds**
1.	T_1	1ml/L Seaweed extract foliar spray (20%)	11.00	11.33	11.67
2.	T_2	2ml/L Seaweed extract foliar spray (20%)	11.60	11.93	12.40
3.	T_3	3ml/L Seaweed extract foliar spray (20%)	12.10	12.43	13.00
4.	T_4	1ml/L Humic acid foliar spray (95%)	12.00	12.33	13.67
5.	T_5	2ml/L Humic acid foliar spray (95%)	12.30	12.63	13.97
6.	T_6	3ml/L Humic acid foliar spray (95%)	13.22	14.99	15.87
7.	T_0	Control	10.20	10.74	10.77
		S.Em (±)	0.55	0.61	0.48
		CD (5%) =	1.72	1.88	1.49
		CV (%) =	8.23	8.58	6.43

Table 2: Influence of foliar spray with Seaweed extract and humic acid on yield t/ha. (Roots)

Yield t/ha. (Roots)					
S. No.	**Tr. No.**	**Treatment Details**	**Distilled water soaked seeds**	**Seaweed soaked seeds**	**Humic acid soaked seeds**
1.	T_1	1ml/L Seaweed extract foliar spray (20%)	5.00	5.43	5.70
2.	T_2	2ml/L Seaweed extract foliar spray (20%)	5.45	5.78	6.12
3.	T_3	3ml/L Seaweed extract foliar spray (20%)	6.31	6.64	6.97
4.	T_4	1ml/L Humic acid foliar spray (95%)	5.80	6.13	6.46
5.	T_5	2ml/L Humic acid foliar spray (95%)	6.68	7.02	7.05

6.	T_6	3ml/L Humic acid foliar spray (95%)	7.10	7.93	8.57
7.	T_0	Control	4.70	4.68	4.84
		S.Em (±)	0.28	0.38	0.52
		CD (5%) =	0.87	1.19	1.62
		CV (%) =	8.32	10.69	14.00

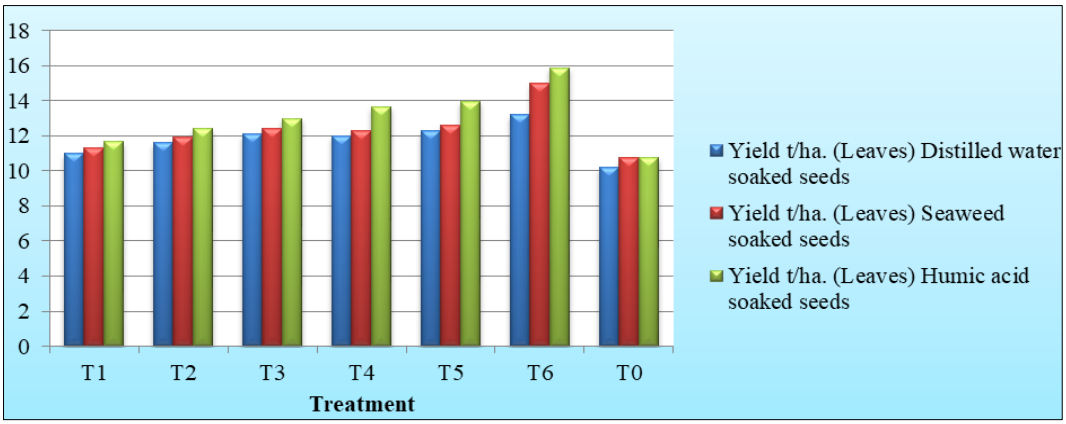

Fig 1: Yield t/ha. (Leaves)

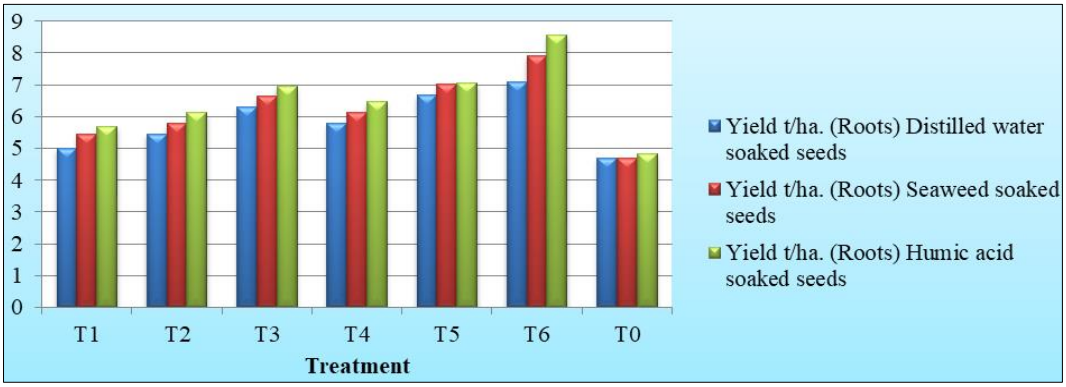

Fig 2: Yield t/ha. (Roots)

Table 3: Influence of foliar spray with Seaweed extract and humic acid on yield kg/plot (Leaves)

Yield kg /plot (Leaves)					
S. No.	**Tr. No.**	**Treatment Details**	**Distilled water soaked seeds**	**Seaweed soaked seeds**	**Humic acid soaked seeds**
1.	T_1	1ml/L Seaweed extract foliar spray (20%)	2.48	2.55	2.63
2.	T_2	2ml/L Seaweed extract foliar spray (20%)	2.61	2.68	2.79
3.	T_3	3ml/L Seaweed extract foliar spray (20%)	2.72	2.80	2.93
4.	T_4	1ml/L Humic acid foliar spray (95%)	2.70	2.77	3.08
5.	T_5	2ml/L Humic acid foliar spray (95%)	2.77	2.84	3.14
6.	T_6	3ml/L Humic acid foliar spray (95%)	2.97	3.37	3.57
7.	T_0	Control	2.30	2.42	2.42
		SEm (±)	0.24	0.32	0.29
		CD (5%) =	0.74	0.97	0.89
		CV (%) =	3.12	2.98	2.59

Table 4: Influence of foliar spray with Seaweed extract and humic acid on yield kg/plot. (Roots)

Yield kg/plot. (Roots)					
S. No.	**Tr. No.**	**Treatment Details**	**Distilled water soaked seeds**	**Seaweed soaked seeds**	**Humic acid soaked seeds**
1.	T_1	1ml/L Seaweed extract foliar spray (20%)	1.13	1.22	1.28
2.	T_2	2ml/L Seaweed extract foliar spray (20%)	1.23	1.30	1.38
3.	T_3	3ml/L Seaweed extract foliar spray (20%)	1.42	1.49	1.57
4.	T_4	1ml/L Humic acid foliar spray (95%)	1.31	1.38	1.45
5.	T_5	2ml/L Humic acid foliar spray (95%)	1.50	1.58	1.59
6.	T_6	3ml/L Humic acid foliar spray (95%)	1.60	1.78	1.93
7.	T_0	Control	1.06	1.05	1.09
		SEm (±)	0.42	0.34	0.40
		CD (5%) =	1.27	1.03	1.21
		CV (%) =	4.56	5.78	5.48

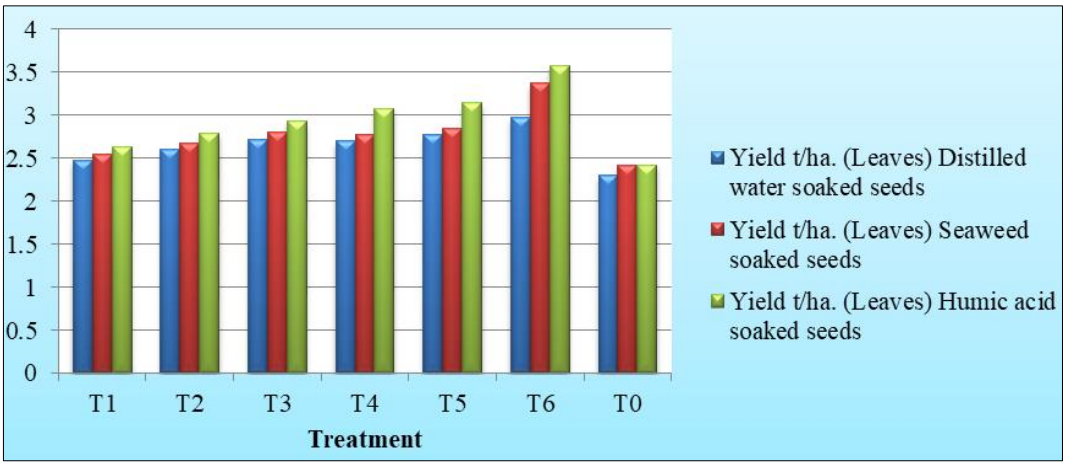

Fig 3: Yield kg per plot (Leaves)

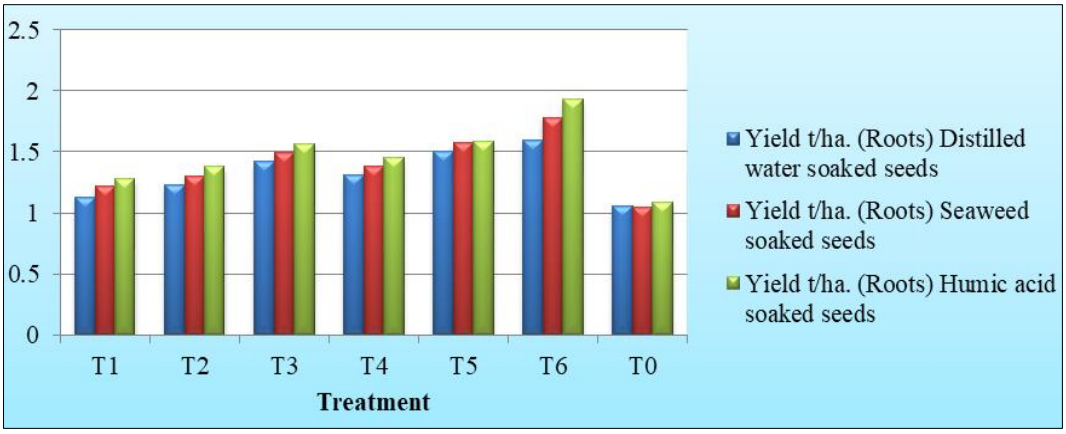

Fig 4: Yield kg per plot. (Roots)

Conclusion

On the basis of above findings, treatment T_6 (3ml/L Humic acid foliar spray (95%)) of Humic acid soaked seeds, stand first in position and treatment T_5 (2ml/L Humic acid foliar spray (95%) of Humic acid soaked seeds, stand in second order of preference. However, treatment T_3 (3ml/L Seaweed extract foliar spray (20%)), comes in next in order. There for it may be concluded that treatment T_6 (3ml/L Humic acid foliar spray (95%) of Humic acid soaked seeds, may be prefer for higher growth, quality and yield in red radish.

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