INFLUENCE OF VARIOUS ORGANIC MANURES ON THE GROWTH AND YIELD OF RADISH AT DIFFERENT GROWTH STAGES (*Raphanus sativus* L.)

ABSTRACT

Applying organic manures is crucial for optimal radish growth and yield due to their rich nutrient content, soil-enriching properties and ability to foster beneficial microbial activity, all of which contribute to healthier plants and improved harvests. A field experiment was conducted to evaluate the influence of different liquid organic manures on growth and yield of radish (*Raphanus sativus*) at organic farming block of Zonal Agricultural Research Station, V. C. Farm, Mandya during late *Kharif* 2020. The experiment was laid in Randomized Complete Block Design with nine treatments and three replications. The experiment consisted of nine treatments of three different levels of nitrogen was applied through FYM and different times of application of Panchagavya and Jeevamrutha. A significant variation was observed among the treatments. The 75% RDN through FYM + two time application of Panchagavya significantly increased the growth and yield attributes at 15, 30, 45 DAS and at harvest *viz*., plant height (8.39, 18.25, 28.16 and 33.06 cm), number of leaves per plant (6.22, 9.11, 16.04 and 18.43), leaf area index (0.08, 0.46, 0.70 and 1.01), root diameter (5.43cm at harvest), fresh shoot weight (8.53, 51.31, 115.29 and 132.43 g plant^{-1}), fresh root weight (2.99, 61.19, 161.08 and 213.08 g plant^{-1}), dry shoot weight (1.11, 10.76, 22.01 and 30.49 g plant^{-1}), dry root weight (0.90, 13.13, 26.74 and 43.28 g plant^{-1}), root yield (38.38 t ha^{-1}) and shoot yield (30.26 t ha^{-1}). In total, the results suggested that 75 per cent recommended dosage of nitrogen was applied through FYM with two times application of panchagavya is proved to be conducive for radish cultivation.

KEYWORDS: Panchagavya, Jeevamrutha, Growth, Yield and Radish

1 INTRODUCTION

"Radish (*Raphanus sativus* L.) is one of important root crop of family Brassicaceae. It is a popular root vegetable in both tropical and temperate regions of world. Radish is grown for its tender root which is consumed either cooked or raw. Leaves and pods of some cultivars can be boiled and eaten as a vegetable. Radish root develops from both the primary root and the hypocotyls" (Rawat and Pant, 2021). "It's a popular vegetable crop that's grown all across the globe. The major radish growing states in India are West Bengal, Haryana, Bihar, Assam, Punjab, Odisha, Chhattisgarh, Madhya Pradesh, Uttar Pradesh, Karnataka and Maharashtra. In India, it was grown in an area of 205 thousand hectares during 2019-20 with an annual production of 3170 thousand metric tons. Radish is a good source of vitamin- A and C and also rich source of minerals like calcium, potassium and phosphorus. Radish contains glucose as the major sugar and smaller quantities of fructose and sucrose. Pink-skinned radishes are generally richer in ascorbic acid than white-skinned ones" (Ghimire *et al*., 2020). "It has *diuretic*, refreshing and cooling properties. It is also used for headache, neurological, sleeplessness and chronic diarrhea. The roots are also useful in urinary complaints, piles, liver and gall bladder complaints" (Umar *et al*., 2019). "The leaves of radish are good source for extraction of protein on a commercial scale and radish seeds are potential source of nondrying fatty oil suitable for soap making illuminating and edible purposes". (Umar et al., 2019)

"Growth, yield and quality of radish greatly depend on soil, climatic conditions and nutrient management. It is well documented fact that the increasing use of chemical fertilizers to increase vegetable production has been widely recognized but continuous and non-judicious use of inorganic inputs or commercial fertilizers have an adverse effect on soil health, environment, beneficial soil microorganisms, human being and leaving residual toxicity in the food products whereby reduces the quality of root and shoot" (Mali *et al*., 2018). "In organic farming only organic manures or natural inputs like weeds, leaf litter and crop residues *etc*., available on the farm are used. Thus, it reduces the cost of production against chemical inputs. Farm yard manure being a bulky organic material reduces the soil compaction and improves the aeration in addition to the supply of essential plant nutrients" (Chaudhary and Narwal, 2005). "Apart from using conventional farm-based products there is an increasing demand for improvised materials like Panchagavya, Jeevamrutha and other liquid organic manures which mainly enrich the soil with indigenous microorganisms. These liquid formulations also contain macro nutrients, micro nutrients, many vitamins, essential amino acids, growth promoting factors like IAA, GA and thus

helps in improving the growth, yield and quality of the crops" (Amalraj *et al*., 2013).. Keeping this in view the present experiment was conducted to study the influence of various organic manures on the growth and yield of radish.

2 MATERIALS AND METHODS

A field experiment was conducted during late *Kharif* 2020 at organic farming block of Zonal Agricultural Research Station (ZARS) V. C. Farm, Mandya, University of Agricultural Sciences, Bangalore. It is located in the Southern Dry Zone of Karnataka (Agro Climatic Zone VI) and Region III at 11° 30' to 13° 05' North latitude and 76° 05' to 77° 45' East longitude with an altitude of 695 meters above mean sea level (MSL). The experiment consisted of nine treatments *viz*., T_1 (100% RDN through FYM), T_2 (50% RDN through FYM + one time application of Jeevamrutha), T_3 (50% RDN through FYM + two time application of Jeevamrutha), T_4 (75% RDN through FYM + one time application of Jeevamrutha), T_5 (75% RDN through FYM + two time application of Jeevamrutha), T_6 (50% RDN through FYM + one time application of Panchagavya), T_7 (50% RDN through FYM + two time application of Panchagavya), T_8 (75% RDN through FYM + one time application of Panchagavya) and T_9 (75% RDN through FYM + two time application of Panchagavya). Panchagavya and Jeevamrutha were applied to soil one at the time of sowing and second application at 30 DAS at the rate of 500 L ha^{-1}. The experiment was laid out in Randomized Block Design with three replications.

Radish variety *Arka Nishanth* developed at Indian Institute of Horticultural Research; Bangalore was used as a test crop. Prior to 15 days of sowing, well decomposed FYM was applied at the rate of 25 t ha^{-1} to the respective experimental plots as per the treatments and it was incorporated with the top soil after application. Radish seeds were dibbled 2 cm down the ridges at a distance of 15 cm in the soil. Thinning was done at 15 days after sowing by rotation one seedling per hill. Seeds were sown in rows at 30 × 15 cm spacing. All the intercultural operations and plant protection measures recommended for the successful crop growth were followed and timely irrigation was given to maintain the proper moisture in the field for better growth and development of the plants.

Randomly five plants from each plot were selected to record the data on plant height (cm), number of leaves per plant, leaf length (cm), leaf area (cm^2), leaf area index,), fresh root weight (g $plant^{-1}$), fresh shoot weight (g $plant^{-1}$), total fresh weight (g $plant^{-1}$), dry root weight (g $plant^{-1}$), dry shoot weight (g $plant^{-1}$), total dry weight (g $plant^{-1}$), root length (cm), root diameter (cm), root yield (t ha^{-1}), shoot yield (t ha^{-1}) and total yield (t ha^{-1}).

The obtained data were statistically analyzed as described by Gomez and Gomez (1984). The significance of variation among the treatments was observed by applying ANOVA. The level of significance used in "F" was P = 0.05. Critical difference (CD) values were calculated for the P = 0.05 whenever "F" test was found significant.

3 Results and discussion:

3.1 Results

3.1.1 Plant height

There was a significant difference in plant height due to application of organic manures. At 15, 30, 45 DAS and at harvest significantly highest plant height (8.39, 18.25, 28.16 and 33.06 cm respectively) was recorded in T_9 (75% RDN through FYM + two times application of Panchagavya) and was on par with the treatments that received 75 per cent RDN through FYM with one- or two-times application of Panchagavya and Jeevamrutha. The studied conducted by Umar *et al*. (2019) and Gyewali *et al*. (2020) also supported the influence of organic manures on plant height in radish.

3.1.2 Number of leaves per plant

T_9 (75% RDN through FYM + two time application of Panchagavya) recorded highest number of leaves per plant (6.22, 9.11, 16.04 and 18.43) at 15, 30, 45 DAS and at harvest which was on par with T_8, T_5 and T_4 which received 75 per cent RDN through FYM with one or two times application of Panchagavya and Jeevamrutha, respectively (Table 1). The findings of Mani and Anburani, (2010) as well as those of Umar *et al*. (2019) and Gyewali *et al*. (2020) support the prior results.

Table 1: Effect of liquid organic manures on plant height and number of leaves at different growth stages of radish crop

Treatment	Plant height (cm)				Number of leaves per plant			
	15	30	45	At	15	30	45	At

	DAS	DAS	DAS	harvest	DAS	DAS	DAS	harvest
T_1	7.28	15.55	20.09	23.95	4.91	7.82	9.88	12.78
T_2	6.56	14.75	18.38	21.58	4.27	6.71	8.29	10.36
T_3	6.66	14.81	23.23	27.68	4.29	6.83	12.88	15.03
T_4	7.73	16.85	20.43	23.73	5.42	8.20	10.32	11.76
T_5	7.84	16.91	25.85	30.47	5.51	8.34	14.81	17.27
T_6	7.07	14.87	19.71	22.45	4.51	7.51	9.63	12.03
T_7	7.11	14.99	24.69	28.40	4.64	7.66	13.63	15.80
T_8	8.30	18.07	21.97	24.56	6.17	9.04	12.05	14.32
T_9	8.39	18.25	28.16	33.06	6.22	9.11	16.04	18.43
S.Em±	**0.33**	**0.71**	**0.96**	**1.14**	**0.51**	**0.35**	**0.51**	**0.62**
CD@ 5%	**0.98**	**2.13**	**2.88**	**3.42**	**NS**	**1.05**	**1.53**	**1.85**

3.1.3 Leaf length, Leaf area and leaf area index

T_9 (75% RDN through FYM + two time application of Panchagavya) recorded highest leaf length (17.24, 26.96, 33.90 and 37.23 cm), leaf area (23.91, 136.77, 209.36 and 302.38 cm^2) and leaf area index (0.08, 0.46, 0.70 and 1.01) over rest of the treatments (Table 2). These results closely correspond with the research conducted by Mani and Anburani, (2010) and Singh *et al*. (2016).

Table 2: Effect of liquid organic manures on leaf length, leaf area and leaf area index at different growth stages of radish crop

Treatment	Leaf length (cm)				Leaf area (cm^2)				Leaf area index			
	15 DAS	30 DAS	45 DAS	At harvest	15 DAS	30 DAS	45 DAS	At harvest	15 DAS	30 DAS	45 DAS	At harvest
T_1	13.82	22.02	26.42	30.58	20.65	119.96	145.31	231.40	0.07	0.40	0.48	0.77
T_2	12.47	20.75	24.91	28.81	19.41	112.93	138.30	225.79	0.06	0.38	0.46	0.75
T_3	12.56	20.83	26.60	32.06	19.47	113.66	152.50	251.73	0.06	0.38	0.51	0.84
T_4	15.35	24.57	27.38	30.31	21.63	125.26	156.39	236.63	0.07	0.42	0.52	0.79
T_5	15.39	24.65	30.03	35.33	21.96	126.62	190.88	290.02	0.07	0.42	0.64	0.97
T_6	13.17	21.26	26.18	30.07	20.06	116.99	149.03	234.30	0.07	0.39	0.50	0.78
T_7	13.26	21.33	29.76	32.71	20.32	117.75	166.27	261.91	0.07	0.39	0.55	0.87
T_8	17.11	26.58	29.04	32.09	23.54	136.14	157.61	257.75	0.08	0.45	0.53	0.86
T_9	17.24	26.96	33.90	37.23	23.91	136.77	209.36	302.38	0.08	0.46	0.70	1.01
S.Em ±	**0.63**	**1.01**	**1.24**	**1.42**	**0.94**	**5.45**	**7.01**	**11.08**	**0.009**	**0.02**	**0.02**	**0.04**
CD@ 5%	**1.90**	**3.04**	**3.73**	**4.24**	**2.82**	**16.33**	**21.01**	**33.22**	**0.003**	**0.05**	**0.07**	**0.11**

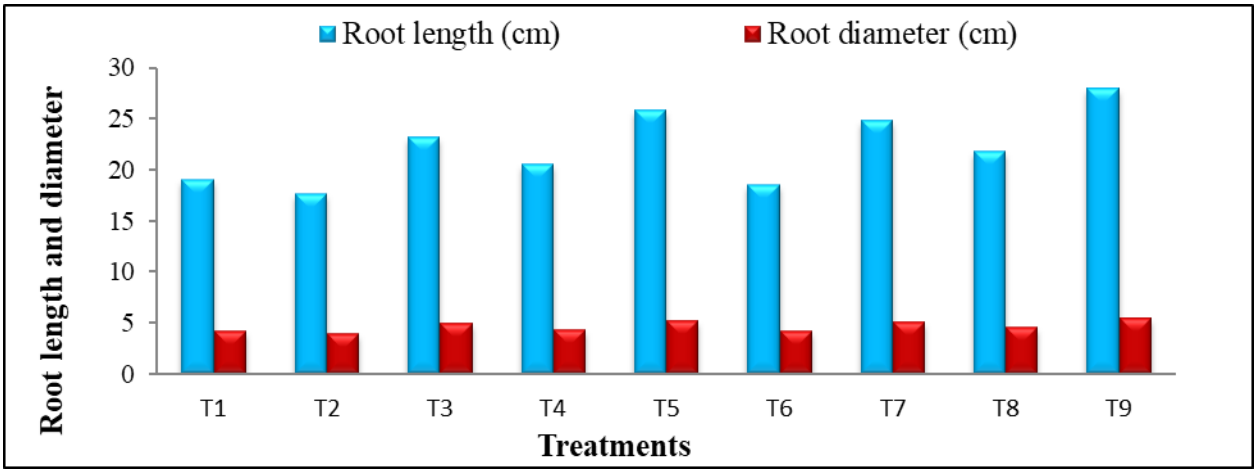

Fig 1: Root length and diameter of radish as influenced by application of liquid organic manures at harvest

3.1.4 Root length and Root diameter

Significant difference with respect to root length and root diameter was observed at harvest (Fig 1). Highest root length of 27.91 cm was recorded in T_9 (75% RDN through FYM + two times application of Panchagavya) and was on par with T_5 (25.74 cm) but significant with rest of treatments. Maximum root diameter 5.43 cm was recorded in the treatment T_9 which received 75% RDN through FYM + two times application of Panchagavya and was on par with the treatments which received two times application of Panchagavya and Jeevamrutha *i.e.*, T_5 (5.10 cm), T_7 (4.95 cm) and T_3 (4.88 cm). The promotive effect of organic manures on root length and root diameter had also been observed by Uddain *et al*. (2010), Kumar *et al*. (2014), Singh *et al*. (2016) and Subedi *et al*. (2018) in radish.

3.1.5 Fresh root weight, fresh shoot weight and total fresh weight

T_9 (75% RDN through FYM + two time application of Panchagavya) recorded highest fresh root weight (2.99, 61.19, 161.08 and 213.08 g plant^{-1}), fresh shoot weight (8.53, 51.31, 115.29 and 132.43 g plant^{-1}) and total fresh weight (11.50, 112.50, 276.37 and 345.51 g plant^{-1}) and lowest was recorded in the treatment 50% RDN through FYM + one time application of Jeevamrutha (T_2) (Table 3). These results were consistent with research by Kanaujia *et al*. (2010), Singh *et al*. (2016) and Gyewali *et al*. (2020) in radish.

Table 3: Effect of liquid organic manures on fresh root weight, fresh shoot weight and total fresh weight at different growth stages of radish crop

Treatment	Fresh root weight (g plant^{-1})				Fresh shoot weight (g plant^{-1})				Total fresh weight (root + shoot) (g plant^{-1})			
	15 DAS	30 DAS	45 DAS	At harvest	15 DAS	30 DAS	45 DAS	At harvest	15 DAS	30 DAS	45 DAS	At harvest
T_1	2.79	52.14	123.03	158.69	6.89	44.31	85.91	102.73	9.68	96.45	208.94	261.42
T_2	2.62	49.36	114.92	141.58	5.06	41.58	82.96	95.39	7.68	90.94	197.88	236.97
T_3	2.74	49.53	138.55	169.88	5.11	41.87	95.61	112.57	7.85	91.40	234.16	282.45
T_4	2.81	57.06	126.78	154.44	7.22	48.19	88.09	103.78	10.03	104.58	214.87	258.22
T_5	2.88	57.98	150.67	189.33	7.47	49.66	105.52	126.60	10.35	106.64	256.19	315.93
T_6	2.63	51.20	122.42	157.08	6.37	42.15	84.08	99.14	8.99	93.35	206.50	256.22
T_7	2.69	51.87	140.53	181.48	6.53	42.74	99.02	116.62	9.22	94.61	239.55	298.10
T_8	2.91	60.77	133.99	166.32	8.52	50.22	90.95	108.37	11.43	110.99	224.94	274.69
T_9	2.99	61.19	161.08	213.08	8.53	51.31	115.29	132.43	11.50	112.50	276.37	345.51
S.Em ±	**0.12**	**3.17**	**5.86**	**7.46**	**0.33**	**1.98**	**4.04**	**4.97**	**0.43**	**4.40**	**9.97**	**12.30**
CD@ 5%	**NS**	**NS**	**17.58**	**22.38**	**0.98**	**5.95**	**12.10**	**14.91**	**1.28**	**13.20**	**29.90**	**36.89**

3.1.6 Dry root weight, dry shoot weight and total dry weight

Highest dry root weight (0.90, 13.13, 26.74 and 43.28 g plant^{-1}), dry shoot weight (1.11, 10.76, 22.01 and 30.49 g plant^{-1}) and total dry weight (2.01, 23.89, 48.75 and 73.77 g plant^{-1}) was recorded in T_9 (75% RDN through FYM + two time application of Panchagavya) and minimum values were observed with T_2 (50% RDN through FYM + one time application of Jeevamrutha) at all the stages of crop growth (Table 4). These findings corroborate with their results obtained by Bhaktavathsalam and Geetha (2004), Sunandarani and Mallareddy (2007), Kumar *et al*. (2009), Kanaujia *et al*. (2010), Singh *et al*. (2016) and Gyewali *et al*. (2020).

Table 4: Effect of liquid organic manures on dry root weight, dry shoot weight and total dry weight at different growth stages of radish crop

Treatment	Dry root weight (g plant^{-1})				Dry shoot weight (g plant^{-1})				Total dry weight (root + shoot) (g plant^{-1})			
	15 DAS	30 DAS	45 DAS	At harvest	15 DAS	30 DAS	45 DAS	At harvest	15 DAS	30 DAS	45 DAS	At harvest
T_1	0.75	10.48	19.45	34.67	0.79	8.57	15.78	22.81	1.54	19.05	35.23	57.48
T_2	0.61	9.63	19.09	33.91	0.66	8.22	14.10	20.32	1.27	17.85	33.19	54.23
T_3	0.64	9.88	22.17	36.39	0.69	8.33	18.39	24.67	1.33	18.21	40.56	61.06
T_4	0.83	12.25	20.67	35.18	0.74	9.29	16.80	22.08	1.87	21.54	37.47	57.26
T_5	0.88	12.86	24.22	41.77	1.05	9.32	20.29	28.49	1.93	22.18	44.51	70.26
T_6	0.69	10.19	21.07	34.21	0.74	8.39	16.07	22.23	1.43	18.58	37.14	56.44

T_7	0.73	10.84	23.70	37.47	0.77	8.46	19.65	26.20	1.50	19.30	43.35	63.67
T_8	0.86	12.74	21.82	35.84	1.06	10.37	17.78	23.73	1.92	23.11	39.60	59.57
T_9	0.90	13.13	26.74	43.28	1.11	10.76	22.01	30.49	2.01	23.89	48.75	73.77
S.Em ±	**0.08**	**1.04**	**0.96**	**1.62**	**0.24**	**0.40**	**0.77**	**1.07**	**0.07**	**0.89**	**1.73**	**2.69**
CD @ 5%	**NS**	**NS**	**2.88**	**4.86**	**0.71**	**1.19**	**2.32**	**3.22**	**0.21**	**2.66**	**5.19**	**8.07**

3.1.7 Root, shoot and total yield of radish

The root, shoot and total yield of radish varied significantly with the application of Panchagavya and Jeevamrutha at different stages (Table 5). Lowest root and shoot yield of 26.19 and 21.24 t ha^{-1}, respectively in T_2 which was significantly increased to 38.38 and 30.26 t ha^{-1}, respectively due to application 75% RDN through FYM + two times application of Panchagavya and it was on par with T_5 (36.08 and 27.35 t ha^{-1}, respectively) which received (75% RDN through FYM + two times application of Jeevamrutha). The extent of root and shoot yield increase with application of 75% RDN through FYM +two times application of Panchagavya was 38.31 and 31.85 was higher than that recorded with the application of 100% RDN through FYM (T_1). The positive response of radish to organic manures with respect to root and shoot yield was evidenced by Kanaujia *et al*. (2010), Jadhav *et al*. (2014), Khalid *et al*. (2015), Ziaf *et al*. (2015) and Singh *et al*. (2016) in radish.

Table 5: Effect of liquid organic manures on root, shoot and total yield of radish crop

Treatment	Root yield (t ha^{-1})	Shoot yield (t ha^{-1})	Total yield (t ha^{-1})
T_1	27.75	22.95	50.70
T_2	26.19	21.24	47.43
T_3	31.58	25.32	56.90
T_4	28.71	22.88	51.59
T_5	36.08	27.35	63.42
T_6	27.01	22.11	49.12
T_7	33.16	26.46	59.62
T_8	29.66	23.73	53.39
T_9	38.38	30.26	68.64
S.Em±	**1.34**	**1.08**	**2.42**
CD@ 5%	**4.02**	**3.25**	**7.27**

3.2 Discussion

Increase in growth parameters that could be obtained with application of Panchagavya and Jeevamrutha can be attributed to higher microbial load and growth hormones which might have enhanced the soil biomass thereby sustaining the availability and uptake of applied as well as native soil nutrients which ultimately resulted in better growth and yield (Boraiah *et al*., 2017). Panchagavya contains kinetin which has a role in enhancing chlorophyll content in plant leaves thus in turn, enhance photosynthetic activity, nitrogen metabolism in plants which ultimately improving the growth parameters (Nileema *et al*., 2011). Further it may be also due to solubilisation of nutrient in soil, absorption of nutrients and moisture due to soil application of Jeevamrutha (Yogananda *et al*., 2015). Similar increase in the growth parameters upon application of organic manures was reported in radish by Uddain *et al*. (2010), Zeid *et al*. (2015), Satish, D, (2016), Pathak *et al*. (2017), Mani *et al*. (2018), Subedi *et al*. (2018), Khatri *et al*. (2019), Gyewali *et al*. (2020) and Basnet *et al*. (2021).

Increase in root length and root diameter might be due to addition of organic manures helps soil micro-organisms to produce polysaccharides and thus lead to better soil structure which is useful for root growth and development (Singh *et al*., 2016). Decrease in bulk density, better aggregation, increase in porosity and water holding capacity of the soil due to organic manures might have contributed in increasing the root length and root diameter of the plants. Similar results of root length and root diameter were also found in radish by Uddain *et al*. (2010), Kumar *et al*. (2014), Singh *et al*. (2016), Subedi *et al*. (2018), Mani *et al.* (2018) and Gyewali *et al*. (2020).

The maximum root and shoot weight could be attributed to the beneficial effect of organics in improving soil texture, aeration, reducing soil compaction and thus enhances the water and nutrient uptake by increasing the permeability of root cell membrane and stimulating the root growth or it may be attributed to solublization of plant nutrients by addition of Panchagavya, Jeevamrutha and FYM leading to increase uptake of NPK. Fresh and dry weights of radish root and shoot results corroborate with their results obtained by Bhaktavathsalam and Geetha (2004), Sunandarani and Mallareddy (2007), Kumar *et al*. (2009), Kanaujia *et al*. (2010), Singh *et al*. (2016) and Gyewali *et al*. (2020).

The observed variation in yield of radish with Panchagavya and Jeevamrutha might be attributed to the application of organic liquid manures enhances the availability of native nutrients to the crops and also improves the soil environment, which stimulated proliferous root system subsequent in better absorption of water and nutrients from the soil resulting in higher uptake and yield (Subramani *et al*., 2010). The positive response of radish to organic manures with respect to root and shoot yield was evidenced by Kanaujia *et al*. (2010), Jadhav *et al*. (2014), Khalid *et al*. (2015), Ziaf *et al*. (2015), Singh *et al*. (2016) and Gyewali *et al*. (2020) in radish.

CONCLUSION:

The organic manures had statistically significant variation ($p<0.05$) in all the growth and yield parameters. The performance of T_9 was found superior in all recorded growth and yield parameters followed by T_5.Therefore, 75% RDN through FYM + two times application of Panchagavya and 75% RDN through FYM+ two times application of Jeevamrutha may be suggested to the radish growing farmers to get better results. This experiment should be conducted in a different agro - climatic zones for further validation.

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