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Growth and Yield of Leafy Radish (*Raphanus sativus* L.) CV. Saisai as Affected by Nitrogen from Organic and Inorganic Fertilizers

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Abstract: *A pot experiment was conducted to study the effects of N from organic and inorganic fertilizers on growth and yield of leafy radish cv. Saisai, (Raphanus sativus L.) at glass house of the Department of Soil Science, University of Chittagong, Bangladesh. There were 10 treatments consisting as follows:- T1 (control), T2 (100% N of recommended dose @ 150 kg N ha^{-1} from urea) , T3 (100% N from cow dung digestate), T4 (100% N from poultry manure digestate), T5 (100% N from raw cow dung), T6 (100% N from raw poultry manure), T7 (50%N from urea+ 50% N from cow dung digestate), T8 (50% N from urea+ 50% N from poultry manure digestate) T9 (50% N from urea+ 50% N from raw cow dung) and T10 (50% N from urea+ 50% N from raw poultry manure). The treatments were arranged in randomized block design with three replications. The results showed that there was a significant effect of different treatments on radish plant height, number leaves $plant^{-1}$, fresh and dry weight of shoot. The maximum number of leaves $plant^{-1}$ was observed with addition of 100%N from raw poultry manure (T6). Application of 50%N from urea+ 50%N from raw poultry manure (T10) and 50%N from urea+ 50%N from raw cow dung (T9) showed the best results in comparison to other treatments in plant height at 35 DAS. However, the highest fresh weight of shoot at harvest at 35 DAS was observed with application of 50%N from urea+ 50%N from raw poultry manure (T10).*

Key words: *Growth, leafy radish, organic fertilizer, inorganic fertilizer.*

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I. Introduction

Vegetables are called shielding food as their consumption can prevent numerous diseases. Vegetables are the source of natural protective food contributing carbohydrates, protein, fats, vitamins and minerals [1]. Radish (*Raphanus sativus* L.) is one of the most ancient and important vegetable crop originated from the central and western China and India. The production of radish is estimated to be about 7 mil. t $year^{-1}$, representing roughly 2% of all vegetables in the world [2]. It is a popular vegetable in both tropical and temperate regions of the world. It is consumed as a salad or cooked as a vegetable. There are several varieties of radish having varying length, size, colour, and taste, yield potential and quality parameters. Chinese radish is increasingly popular throughout the world. In Asia, especially in China and Japan, it is one of the principal vegetables [3]. The most popular eating part of radish is the tuberous root. Leaves and pods of some cultivars can be boiled and eaten as a vegetable. The cultivars of radish that may be used as leafy vegetables are Saisai, hybrid; Pesto BLTs, Hybrid Hattor etc. [4].Radish is a good source of Vitamin C (ascorbic acid) and minerals like calcium, potassium and phosphorus. The presence of a variety of nutrients in radish leaves makes it a versatile herb that can cure and alleviate a variety of diseases [5]. The high iron and phosphorus content of radish leaves increases immunity and reduces fatigue. It also contains fibre that helps in digestive process. In homeopathy, it is used for neurological, headache, sleeplessness and chronic diarrhea. The roots are also useful in urinary complaints and piles. The leaves of radish are good source for extraction of protein on a commercial scale and radish seeds are potential source of non-drying fatty oil suitable for soap making illuminating and edible purposes [6].

A several factors such as soil, varieties, fertilizer management and various agro techniques used for growing crop influence the growth and yield of radish. Among the agro-techniques, nutrition is one of the main factors which govern the growth and yield of radish. In order to obtain optimum yield and high quality produce, nutrition should be emphasized in the production of radish [7]. Nutrients play a vital role in functioning of normal physiological processes during the period of growth and development of plants. Nitrogen is the most essential among the nutrients and one of the most important growth factors in controlling yield and quality of most vegetables crops [8]. However, for obtaining higher economic yield, balanced supply of nutrients is one of the key factors [9]. The dependence on expensive chemical inputs can be reduced by the integrated use of organic and chemical fertilizers. The organic sources are directly or indirectly helpful in increasing the availability and uptake of nutrients from the soil and ultimately to boost up the yield and quality of crops without rendering the detrimental effects on physicochemical properties of the soil. Hence, for the production of good quality radish optimum fertilization through organic and inorganic fertilizers are essential [10]. Organic farming belongs to the fastest expanding sectors of the food industry in many European countries for many years [11]. The consumer demand for organic products is increasing in recent years [12]. Because of higher cost of inorganic fertilizer and its contribution to deteriorate health of soil and water, the farmers are looking for alternative and cheaper sources, which may lower down the cost of cultivation along with maintaining the fertility status of soil. The responses of organic sources with or without chemical fertilizer have been reported by several workers on a large number of crops like ladies finger (okra) [13, 14, 15], maize [16] and amaranth [17]. Keeping in view the contents noted above, the present investigation was carried out to study the comparative effects of organic and inorganic fertilizers on growth and yield of leafy radish cv. Saisai, a popular variety for harvesting radish leaves.

II. Materials and Methods

Pot experiment

In order to study the effects of N from organic and inorganic fertilizer on growth and yield of leafy radish cv. Saisai, a pot experiment was conducted at glass house of the Department of Soil Science, University of Chittagong. There were 10 treatments consisting as following: T1 (control), T2 (100% N of recommended dose @ 150 kg N ha^{-1} from urea) , T3 (100% N from cow dung digestate), T4 (100% N from poultry manure digestate), T5 (100% N from raw cow dung), T6 (100% N from raw poultry manure), T7 (50%N from urea+ 50% N from cow dung digestate), T8 (50% N from urea+ 50% N from poultry manure digestate) T9 (50% N from urea+ 50% N from raw cow dung) and T10 (50% N from urea+ 50% N from raw poultry manure). All treatments were determined based on the N requirement of radish for high yield goal on the basis of initial soil test value according to BARC [18](2012). Each treatment with three replications was mixed with sieved soil prior to filling @ 8 kg per pot. The pots were arranged according to randomized complete block design. All treatments except control received recommended doses of P (45 kg P ha^{-1}) and K(120 kg K ha^{-1}) according to BARC [18] as triple super phosphate (TSP) and muriate of potash (MP), respectively along with N (150 kg N ha^{-1}) as urea according to treatment plan. One-third of the nitrogen and all the phosphorus and potassium fertilizers were applied as basal dose prior to sowing, while remaining two thirds of nitrogen was applied in equal amounts at 15 and 30 DAS as top dressing followed by irrigation. All of cow dung digestate, poultry manure digestate, raw cow dung and raw poultry manure were applied as basal during soil preparation and soils mixed with these amendments were allowed to equilibrate for 2 weeks prior to sowing seeds. Healthy seeds of radish were sown in the pots. Six healthy seedlings of about uniform size were kept in each pot by thinning after seedling emergence. Irrigation and other cultural operation was applied as and when necessary.

Data Collection

Growth parameters such as plant height and number of leaves of radish were recorded at 10, 20 and 35 days after sowing. Fresh and dry weight of shoot and root biomass were recorded after harvest at 35 DAS. Dry weight was measured after drying in an oven at 65^0C for 72 hours.

Properties of soil and organic amendments

Soil texture was determined by hydrometer method [19], pH in a 1:2.5 soil: water suspension with glass electrode pH meter, organic carbon by wet-oxidation method [20], total nitrogen by micro-Kjeldahl digestion and distillation, available phosphorus by Bray and Kurtz-II method [21]. Organic matter was calculated by multiplying the organic carbon content with 1.72. The same methods used for soil were followed for determination of the properties of cow dung digestate, poultry manure digestate, raw cow dung and poultry manure. The experimental soil was sandy clay loam in texture containing 60% sand, 18% silt and 22% clay. Soil pH was 6.74, organic matter content 1.61%, total nitrogen 0.19%. Total nitrogen content of the digestate from cow dung and poultry manure was 1.14 % and 1.13%, respectively. Raw cow dung and poultry manure contained total nitrogen 1.40%% and 1.83%, respectively.

Statistical analysis

The significance of differences among the means of the treatments was evaluated by one way analysis of variance followed by Duncan's Multiple Range Test at the significance level of 5%. The statistical software Microsoft Excel [22] and SPSS version 16 [23] were used for the analysis.

III. Results and Discussion

Plant height

There was a significant effect of different treatments on radish plant height and the values shown in Table 1. Plant height varied from 10.58 to 16.09 cm at 10 DAS, 12.87 to 23.71 cm at 20 DAS, and 13.55 to 28.79 cm at 35 DAS. The radish fertilized with 100% N from raw poultry manure (T6), 50% N from urea+50% N from cow dung digestate (T7) resulted in maximum plant height at 10 and 20 DAS. The maximum plant height of 28.79 cm at 35 DAS was found with addition of 50%N from urea+50%N from raw cow dung (T9) and 50%N from urea+50% N from raw poultry manure (T10). The minimum plant height of radish at all growth stages of recording was observed in control treatment (T1) receiving no organic or inorganic fertilizers.

All of the treatments with urea, biogas digestate from cow dung and poultry manure, raw cow dung and poultry manure significantly increased plant height of radish at 20 and 35 DAS compared to control but not all at 10 DAS. Addition of 50% N from urea +50% N from cow dung digestate (T7), 50% N from urea +50% N from poultry manure digestate (T8), 50% N from urea +50% N from raw cow dung (T9), 50% N from urea +50% N from raw poultry manure (T10) showed significantly better results in plant height than 100% N from urea (T2) at 20 DAS and 35 DAS. However, the treatments T7, T8, T9 and T10 were similar in plant height at 20 and 35 DAS. There was not significantly different between cow dung digestate and poultry manure digestate; and between raw cow dung and raw poultry manure in plant height at 20 and 35 DAS. Similar results were found between cow dung digestate and raw cow dung and between poultry manure digestate and raw poultry manure at 35 DAS. Generally, combined application of the organic amendments with urea showed better performance in plant height than their application alone for supplying nitrogen for radish growth.

Table 1 Plant height of leafy radish cv Saisai, hybrid as affected by different treatments

Treatment	Plant height (cm)		
	10 DAS	20 DAS	35 DAS
T1	10.58 d	12.87 d	13.55 c
T2	14.82 ab	16.51 c	23.71 b
T3	12.70 c	18.63 bc	26.25 ab
T4	13.12 bc	19.47 b	27.09 ab
T5	11.85 cd	20.74 ab	26.25 ab
T6	16.09 a	21.59 ab	27.09 ab
T7	14.82 ab	23.71 a	27.94 a
T8	12.70 c	22.61 a	27.52 a
T9	11.43 cd	21.59 ab	28.79 a
T10	11.85 cd	23.28 a	28.79 a
Significance of F value	0.001	0.001	0.001

Figures in the column denoted by same letter (s) did not differ significantly ($p < 0.05$)

Number of leaves plant^{-1}

Mean values of the number of leaves plant^{-1} of leafy radish recorded at 10, 20 and 35 days after sowing (DAS) of seeds are given in Table 2. The number of leaves plant^{-1} varied from 3.67 to 5.00, 4.33 to 6.00 and 6.33 to 9.33 at 10 DAS, 20 DAS and 35 DAS, respectively. The minimum number of leaves plant^{-1} was found at the control treatment (T1) in all the periods of recording at 10 DAS, 20 DAS and 35 DAS while the maximum number of leaves plant^{-1} was observed in treatment T6 and T7 at 20 DAS ; and T6 at 35 DAS. A significant variation in number of leaves plant^{-1} was observed among the treatments at 20 DAS and 35 DAS but not at 10 DAS. Application of 100%N from urea fertilizer (T2) gave significantly higher number of leaves plant^{-1} compared to control at 35 DAS but not at 20 DAS. The number of leaves plant^{-1} obtained with 100% N of recommended dose from cow dung digestate (T3) and 100% N from poultry manure digestate (T4) were similar to that with control treatment (T1) both at 20 DAS and 35 DAS. Addition of 100%N from raw poultry manure (T6) gave significantly higher number of leaves plant^{-1} than 100%N from raw cow dung (T5) at 35 DAS. Application of 50% N from urea +50% N from cow dung digestate (T7), 50% N from urea +50% N from poultry manure digestate (T8), 50% N from urea +50% N from raw cow dung (T9), 50% N from urea +50% N from raw poultry manure (T10) showed similar results with 100% N from urea (T2) at 20 DAS and 35 DAS but significantly higher number of leaves plant^{-1} than control.

Table 2 Number of leaves plant^{-1} of leafy radish cv Saisai, hybrid as affected by different treatments

Treatment	Number of leaves plant^{-1}		
	10 DAS	20 DAS	35 DAS
T1	3.67 a	4.33 b	6.33 e
T2	4.67 a	5.33 ab	8.33 abc
T3	4.33 a	5.00 ab	7.33 cde
T4	4.33 a	5.33 ab	6.33 e
T5	4.33 a	5.33 ab	8.00 bc
T6	5.00 a	6.00 a	9.33 a
T7	4.67 a	6.00 a	8.67 ab
T8	4.33 a	5.33 ab	7.67 bcd
T9	4.67 a	5.00 ab	7.67 bcd
T10	4.33 a	5.33 ab	7.67 bcd
Significance of F value	NS	0.05	0.001

Figures in the column denoted by same letter (s) did not differ significantly ($p < 0.05$)

Fresh weight of shoot and root

The growth responses of radish in terms of fresh weight of shoot and root to different organic and inorganic fertilizer has been presented in Table 3. Fresh weight of shoot and root varied from 63.86-116.08 g pot^{-1} and 11.09 -15.11 g pot^{-1}, respectively. The highest fresh weight of shoot and root was obtained with addition of 50%N from urea+ 50%N from raw poultry manure (T10) followed by 50%N from urea+ 50%N from raw cow dung (T9) and 100% N from urea (T2). The lowest fresh weight of shoot and root was obtained with control treatment T1 where neither organic nor inorganic fertilizer was applied. Application of cow dung biogas digestate, poultry manure digestate, raw cow dung, raw poultry manure and urea alone or their different combinations significantly increased fresh weight of radish shoot but not root in comparison to control treatment. Fresh weight of shoot with T4 (100%N from poultry manure digestate) and T8 (50%N from urea+50%N from poultry manure digestate) was significantly lower than T10 (50%N from urea+50%N from raw poultry manure) but higher than control (T1). The treatments T2, T3, T5, T6, T7 and T9 were statistically similar to T10 in producing fresh weight of radish shoot.

Dry weight of shoot and root

Dry weight of shoot and root of leafy radish ranged from 8.54 to 11.89 g pot^{-1} and 1.26 to 1.70 g pot^{-1}, respectively (Table 3). The lowest dry weight of both shoot and root was found in treatment T1 (control); and the highest shoot weight was found at T10 (50% N from urea+ 50% N from raw poultry manure) and root weight was found at T7 (50% N from urea+ 50% N from cow dung digestate). Similar to fresh weight, dry weight of radish shoot was also significantly increased by inorganic and organic fertilizers compared to control except applying 100%N from poultry manure digestate (T4) and 100%N from raw cow dung (T5). However, shoot dry weight of leafy radish found with T3 (100%N from cow dung digestate), T7 (50%N from urea+ 50%N from cow dung digestate), T8 (50%N from urea+ 50%N from poultry manure digestate) and T9 (50%N from urea+ 50%N from raw cow dung) was comparable to T10 (50%N from urea+ 50%N from raw poultry manure).

Table 3 Fresh and dry weight of leafy radish cv Saisai, hybrid as affected by different treatments

Treatment	Fresh weight (g pot^{-1})		Dry weight (g pot^{-1})	
	Shoot	Root	Shoot	Root
T1	63.86 c	11.09 a	8.54 d	1.26 a
T2	102.55 ab	12.49 a	9.85 bc	1.44 a
T3	95.73 ab	12.70 a	10.38 ab	1.49 a
T4	85.25 b	13.55 a	9.04 cd	1.54 a
T5	99.56 ab	11.09 a	8.90 cd	1.54 a
T6	94.17 ab	12.50 a	9.47 bc	1.43 a
T7	99.34 ab	13.05 a	10.35 ab	1.70 a
T8	89.82 b	11.24 a	10.49 ab	1.43 a
T9	102.96 ab	14.92 a	10.78 ab	1.52 a
T10	116.08 a	15.11 a	11.89 a	1.61 a
Significance of F value	0.01	NS	0.01	NS

Figures in the column denoted by same letter (s) did not differ significantly ($p < 0.05$)
NS= Not significant

The findings of the study revealed a significant effect of different treatments on plant height, number leaves plant^{-1}, fresh and dry weight of shoot of leafy radish cv. Saisai, hybrid. The results of the present study are in conformity with that of Shaheb et al., [24] who reported that cow dung (CD) bio-slurry along with IPNS basis inorganic fertilizer dose for HYG has a positive effect to increment of radish yield. Increased shoot weight of leafy radish obtained in the study also confirmed the results as reported by Warnars and Oppenoorth [25]. Furthermore the results are also similar to that of Shaheb and Nazrul [26] who reported that CD slurry @ 5 t ha^{-1} along with IPNS basis inorganic fertilizers produced the highest yield of cabbage. In agreement with the present findings, Grameen Shakti [27] reported favourable influences of cow dung and poultry litter biogas residues in increasing the yields of cabbage, brinjal and tomato. The increase in growth and yield of maize due to application of biogas digestate was reported by Islam et al. [28]. The biogas digestate contains organic nitrogen, readily available nutrients, hormones, humic acids and vitamins etc. [29, 30] which can enhance plant growth and yield through enhanced nutrient availability and improved soil health.

The combined application of the organic amendments with urea showed better performance in plant height than their application alone for radish growth. These results are in agreement with the findings of Khan et al. [31], Parvez et al.[32] and Rahman et al., [33]. In another study by Begum et al. [34] on integrated use of poultry manure and biogas slurry with chemical fertilizer in rice-okra cropping sequence, application of urea alone or in combination with organic manures had a positive effect on grain, straw, and biological yield of rice. They found the highest grain, straw and biological yield with treatment receiving 50%N from urea+50%N from poultry manure which was at par with 50%N from urea+50%N from biogas slurry. Raw poultry manure showed comparatively better results than poultry manure digestate in fresh weight and dry weight of radish in the present study. Again, application of raw poultry manure in combination with urea (50%N from urea+ 50% N from raw poultry manure) produced higher fresh and dry weight than raw poultry manure alone. This finding was supported by Kibria et al. [14] who reported that application of 50% NPK+50% poultry manure proved most effective in growth and fresh fruit yield of ladies finger in valley soils of Chittagong, Bangladesh. Karim *et al.* [35] also reported that integrated nutrient management (INM) through poultry manure along with reduced rate of recommended dose of fertilizer (RDF) performed the best in recording yields of okra. The integrated use of organic sources and inorganic sources of nutrients have some positive interaction to increase nutrient use efficiency in addition to supplying essential nutrients and thereby reduce environmental hazards [36, 37].

IV. Conclusion

Application of urea, cow dung digestate, and poultry manure digestate, raw cow dung and raw poultry manure increased plant height, number of leaves $plant^{-1}$; fresh and dry weight of shoot of leafy radish cv. Saisai, Hybrid. Addition of the organic amendments in combination with urea showed comparatively better results than their individual application. Application of 50%N from urea+ 50%N from raw poultry manure may be recommended for leafy radish cultivation with a hazardless environment.

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