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Effects of different types of organic fertilizers on growth performance and yield attributes of radish (*Raphanus sativus* L.) cv. Mino early long

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Abstract
Experiment titled Effects of Different Types of Organic Fertilizers on Growth Performance and Yield attributes of Radish (*Raphanus sativus* L.) cv. Mino Early Long during Rabi Season 2020-2021 on research farm of the Department Horticulture, AKS University, Satna (MP). The experiment was placed in a randomized block design with three repeated 11 treatments *viz.*, T_1: Control (Without any fertilizer), T_2: Biocher @ 2t/ha, T_3: Soybean Meal @1t/h + Biocher @ 2t/ha, T_4: Soybean Meal @1t/h + VC@ 10t/h+ Biochar @ 2t/ha, T_5: Soybean Meal @1t/h + PM@ 25t/h+ Biochar @ 2t/ha, T_6: Soybean Meal @1t/h + VC@ 10t/h + PM@ 25t/h+ Biochar @ 2t/ha, T_7: Biocher @ 4t/ha, T_8: Soybean Meal @1t/h + Biocher @ 4t/ha, T_9: Soybean Meal @1t/h + VC@ 10t/h+ Biochar @ 4t/ha, T_{10}: Soybean Meal @1t/h + PM@ 25t/h+ Biochar @ 4t/ha, T_{11}: Soybean Meal @1t/h + VC@ 10t/h + PM@ 25t/h+ Biochar @ 4t/ha. The results reveal that increase in Soybean Meal, PM, Biochar and Vermicompost level had significant response on vegetative growth yield and quality of Radish. The the treatment T_{11}- Soybean Meal @1t/h + VC@ 10t/h + PM@ 25t/h+ Biochar @ 4t/ha was found in better growth and higher yield. In this investigation the treatment T_{11}- Soybean Meal @1t/h + VC@ 10t/h + PM@ 25t/h+ Biochar @ 4t/ha was found suitable for cultivation in *Rabi* season for better yield with quality corrector.

Keywords: Radish, soybean meal, PM, biochar and vermicompost

Introduction
Radish is an important crop among root vegetable. Radish roots are good source of vitamin 'C' and it contains 15-45 mg of ascorbic acid in 100g of edible part. Some radish roots are red in colour which is high in ascorbic acid content. The pungency of Radish is due to presence of isothiocynate and red colour is due to anthocynanin. Radish is cross – pollinated crop and pollination takes place by Honeybees. Radish is cultivated throughout in India West Bengal, Uttar Pradesh, Punjab, Assam Haryan Gujrat and Himachal Pradesh is major radish producing states. Organic agriculture is derived as a production system which largely excludes or completely avoids the use of synthetically compounded pesticides, fertilizers, growth regulators, preservatives and livestock feed additives, organic agriculture practices thus rely upon recycling of crop residues, animal manure, off-farm organic residues and wastes. Organic agriculture is gaining movement in India due to the individual as well as group efforts to conserve environments and avoid contamination of the farm produce from the use of chemical fertilizers and pesticides. The important tenet of organic food movement is that promotes ecological soundness and sustainable use of natural resources, also maintenance of crop diversity. Application of Biochar to soil as a technique to improve the quality of soil has emerged in recent years. It has the ability to aid in coping up with the greenhouse gases (GHG) and is helpful for carbon sequestration. Vermicompost is nothing but the excreta of earthworms, which is rich in humus and nutrients. Vermicompost also contains a high proportion of humic substances (humic acids, fulvic acids and humin) which provide numerous sites for chemical reaction; microbial components known to enhance plant growth and disease suppression through the activities of bacteria (*Bacillus*) and fungi. Soybean meal is a high nitrogen fertilizer that also contains low amounts of phosphorus and calcium. Local growing conditions tend to affect how fast this product is absorbed into the soil but this process normally occurs at moderate rates of speed. However, soybean meal is fairly useful as a long term soil conditioner. Adequate supply of fertilizers can promote plant growth and increase crop production, but excessive and improper use of chemical fertilizers leads to the

accumulation of compounds in food products that have harmful effects on human health, environmental pollution and cause economic loss.

Materials and Methods

Experiment titled Effects of Different Types of Organic Fertilizers on Growth Performance and Yield attributes of Radish (*Raphanus sativus* L.) cv. Mino Early Long during Rabi Season 2020-2021 on research farm of the Department Horticulture, AKS University, Satna (MP). The experiment was placed in a randomized block design with three repeated 11 treatments *viz.*, T_1: Control (Without any fertilizer), T_2: Biocher @ 2t/ha, T_3: Soybean Meal @1t/h + Biocher @ 2t/ha, T_4: Soybean Meal @1t/h + VC@ 10t/h+ Biochar @ 2t/ha, T_5: Soybean Meal @1t/h + PM@ 25t/h+ Biochar @ 2t/ha, T_6: Soybean Meal @1t/h + VC@ 10t/h + PM@ 25t/h+ Biochar @ 2t/ha, T_7: Biocher @ 4t/ha, T_8: Soybean Meal @1t/h + Biocher @ 4t/ha, T_9: Soybean Meal @1t/h + VC@ 10t/h+ Biochar @ 4t/ha, T_{10}: Soybean Meal @1t/h + PM@ 25t/h+ Biochar @ 4t/ha, T_{11}: Soybean Meal @1t/h + VC@ 10t/h + PM@ 25t/h+ Biochar @ 4t/ha. The seeds were sown on 25th November- 2020, germination started and completed on 29 November the recording of observations was done 20 days after sowing and subsequent readings were recorded after every 20 days interval . The crop was harvested on 12th January- 2021. All facilities required for farming including labor were provided in the department. Well rotten The experimental field was prepared and ploughed with a disc harrow by tractor drawn two times with cultivator and well levelled by planker before sowing. After that rocks and debris were removed from the field soil. After field preparation, the area was marked and laid out as per plan.Organic manures (Soybean Meal, VC, PM and Biochar) help plants to quick uptake of nutrients from soil, increase nutrient availability in soil and reduce soil pollution, minimize soil erosion and degradation, improve nutritional security and reduce many problems related to crop production. On the basis of crop requirements the basal dressing of organic manure of well rotten farm yard manures was applied in the field after the field was prepared. It was mixed up thoroughly before sowing the seeds in the entire plot. For proper growth and development Seed rate of 7-8 Kg/ha is followed. Radish seeds are directly sown in a well prepared field or beds having sufficient soil moisture. Seeds are sown to a depth of 1cm and after sowing the seeds were properly covered with soil by the use of rake. The observations were made at 20, 40 and at harvest. The data recorded during the investigation were subjected to statistical analysis according to the method of analysis of variance (Panse and Sukhatme, 1967). Significance and non-significance of treatment effect were assessed with the help of the 'F' variance ratio test. The calculated 'F' value (variance ratio) was compared with the table value of F' at the 5% significance level. If the calculated value is greater than the table value, the effect was considered significant. Significant differences between means were tested against significant differences at the 5% significance level.

Result

Data mentioned in table 1 clearly revealed that the optimum levels of nutrients were found to significantly improve plant height at all the growth stages. Maximum plant height recorded in T_{11}- Soybean Meal @1t/h + VC@ 10t/h + PM@ 25t/h+ Biochar @ 4t/ha (38.69 cm) at harvest closely followed by 36.18 cm with T_6- Soybean Meal @1t/h + VC@ 10t/h + PM@ 25t/h+ Biochar @ 2t/ha and the minimum plant height (17.56 cm) was recorded with T_1- Control. Maximum number of leaves per plant recorded in Treatment T_{11}- Soybean Meal @1t/h + VC@ 10t/h + PM@ 25t/h+ Biochar @ 4t/ha (19.47) at harvest closely followed by 17.55leaves per plant with T_6- Soybean Meal @1t/h + VC@ 10t/h + PM@ 25t/h+ Biochar @ 2t/ha and the minimum number of leaves per plant (10.71) was recorded with T_1- Control. Maximum leaf length (cm) was recorded in treatment T_{11}- Soybean Meal @1t/h + VC@ 10t/h + PM@ 25t/h+ Biochar @ 4t/ha (34.51 cm) followed by 24.78 cm leaf length with T_6- Soybean Meal @1t/h + VC@ 10t/h + PM@ 25t/h+ Biochar @ 2t/ha and the minimum leaf length (12.33 cm) was recorded with T_1- Control. Leaf Width was recorded in treatment T_{11}- Soybean Meal @1t/h + VC@ 10t/h + PM@ 25t/h+ Biochar @ 4t/ha (8.13 cm) followed by Leaf Width (8.07 cm) with T_6- Soybean Meal @1t/h + VC@ 10t/h + PM@ 25t/h+ Biochar @ 2t/ha and the minimum Leaf Width (4.67 cm) was recorded with T_1- Control. These results closely match with the findings of Sharma *et al.* (2002) [12], Baloch *et al.* (2014) [2], Krishnkant *et al.* (2018) [6], Poonkodi *et al.* (2019) [9], Shormin and Kibria (2019) [13]. Maximum Leaf area (cm^2) recorded was in treatment T_{11}- Soybean Meal @1t/h + VC@ 10t/h + PM@ 25t/h+ Biochar @ 4t/ha (323.58 cm^2) followed by leaf area (319.26 cm^2) with T_6- Soybean Meal @1t/h + VC@ 10t/h + PM@ 25t/h+ Biochar @ 2t/ha and the minimum leaf area (216.72 cm^2) was recorded with T_1- Control. Treatment T_{11}- Soybean Meal @1t/h + VC@ 10t/h + PM@ 25t/h+ Biochar @ 4t/ha recorded maximum leaf : Root ratio (1.94) followed by leaf : Root ratio (1.91) with T_6- Soybean Meal @1t/h + VC@ 10t/h + PM@ 25t/h+ Biochar @ 2t/ha) and the minimum leaf : Root ratio (1.51) was recorded with T_1- Control. Treatment T_{11}- Soybean Meal @1t/h + VC@ 10t/h + PM@ 25t/h+ Biochar @ 4t/ha recorded maximum fresh weight of root (117.52 g) followed by fresh weight of root (114.18 g) with T_6- Soybean Meal @1t/h + VC@ 10t/h + PM@ 25t/h+ Biochar @ 2t/ha and the minimum fresh weight of root (46.41g) was recorded with T_1- Control. Treatment T_{11}- Soybean Meal @1t/h + VC@ 10t/h + PM@ 25t/h+ Biochar @ 4t/ha recorded maximum length of root (34.20 cm) followed by length of root (33.76 cm) with T_6- Soybean Meal @1t/h + VC@ 10t/h + PM@ 25t/h+ Biochar @ 2t/ha and the minimum length of root (15.83 cm) was recorded with T_1- Control. Treatment T_{11}- Soybean Meal @1t/h + VC@ 10t/h + PM@ 25t/h+ Biochar @ 4t/ha recorded maximum diameter of root (4.19 cm) followed by (4.13 cm) with T_6- Soybean Meal @1t/h + VC@ 10t/h + PM@ 25t/h+ Biochar @ 2t/ha and the minimum diameter of root (2.53 cm) was recorded with T_1- Control. The results of present study are almost matched with the findings of Sharma (2000) [11], Yulin Liao (2009) [14], Jawad *et al.* (2015) [4], Maia *et al.* (2018) [8] and Khatri *et al.* (2019) [5]. Treatment T_{11}- Soybean Meal @1t/h + VC@ 10t/h + PM@ 25t/h+ Biochar @ 4t/ha recorded maximum average weight of root (117.42 g) followed by (112.77 g) with T_6- Soybean Meal @1t/h + VC@ 10t/h + PM@ 25t/h+ Biochar @ 2t/ha and the minimum average weight of root (46.79 g) was recorded with T_1- Control. Treatment T_{11}- Soybean Meal @1t/h + VC@ 10t/h + PM@ 25t/h+ Biochar @ 4t/ha recorded maximum root yield per plot (2.935 kg) followed by (2.819 kg) with T_6- Soybean Meal @1t/h + VC@ 10t/h + PM@ 25t/h+ Biochar @ 2t/ha and the minimum root yield per plot (1.169 kg) was recorded with T_1- Control. Treatment T_{11}- Soybean Meal @1t/h + VC@ 10t/h + PM@ 25t/h+ Biochar @ 4t/ha recorded maximum root yield (0.806 t/ ha) followed by (0.721 t/ ha) with T_6- Soybean Meal @1t/h + VC@ 10t/h + PM@ 25t/h+ Biochar @ 2t/ha and the minimum root yield (0.113 t/ ha) was recorded with T_1- Control. Treatment T_{11}-

Soybean Meal @1t/h + VC@ 10t/h + PM@ 25t/h+ Biochar @ 4t/ha recorded maximum chlorophyll (113.58 mg/100g) followed by (113.20 mg/100g) with T_6- Soybean Meal @1t/h + VC@ 10t/h + PM@ 25t/h+ Biochar @ 2t/ha and the minimum chlorophyll (81.35 mg/100g) was recorded with T_1- Control. Treatment T_{11}- Soybean Meal @1t/h + VC@ 10t/h + PM@ 25t/h+ Biochar @ 4t/ha recorded maximum Ascorbic Acid (18.86 mg/100g) followed by Ascorbic Acid (18.51 mg/100g) with T_6- Soybean Meal @1t/h + VC@ 10t/h + PM@ 25t/h+ Biochar @ 2t/ha and the minimum Ascorbic Acid (14.72 mg/100g) was recorded with T_1- Control. Treatment T_{11}- Soybean Meal @1t/h + VC@ 10t/h + PM@ 25t/h+ Biochar @ 4t/ha recorded maximum TSS (5.07 ^{O}Brix) followed by TSS (5.02 ^{O}Brix) with T_6- Soybean Meal @1t/h + VC@ 10t/h + PM@ 25t/h+ Biochar @ 2t/ha and the minimum TSS (4.03 ^{O}Brix) was recorded with T_1- Control.Results related to fresh weight (g) of Radish found to be close agreement with that of Renuka and Ravishankar (2001) [10], Asghar *et al.* (2006) [1], Chorol *et al.* (2018) [3] and Kushwah *et al.* (2020) [7]. The results reveal that increase in Soybean Meal, PM, Biochar and Vermicompost level had significant response on vegetative growth yield and quality of Radish. The the treatment T_{11}- Soybean Meal @1t/h + VC@ 10t/h + PM@ 25t/h+ Biochar @ 4t/ha was found in better growth and higher yield. In this investigation the treatment T_{11}- Soybean Meal @1t/h + VC@ 10t/h + PM@ 25t/h+ Biochar @ 4t/ha was found suitable for cultivation in *Rabi* season for better yield with quality corrector.

Table 1: Effects of Different Types of Organic Fertilizers on Growth Performance and Yield attributes of Radish

Treatments	Plant high (cm)	Number of leaves /plant	Leaf length (cm)	Leaf width (cm)	Leaf area (cm^2)	Leaf : Root ratio	Fresh weight of root (g)	Length of root (cm)	Diameter of root (cm)	Average weight of root (g)	Root yield per plot (kg)	Root yield (t/ ha)	Chlorophyll (mg/100g)	Ascorbic Acid (mg/100g)	TSS (^{O}Brix)
T_1	17.56	10.71	19.54	4.67	216.72	1.51	46.41	15.83	2.53	46.79	1.169	0.113	81.35	14.72	4.03
T_2	25.08	11.23	24.31	5.25	237.02	1.62	64.27	21.19	3.16	64.11	1.602	0.237	100.64	16.11	4.37
T_3	27.03	12.84	27.80	6.07	268.97	1.81	70.21	25.97	3.35	70.28	1.757	0.434	105.82	17.30	4.50
T_4	30.89	14.18	29.33	6.39	292.60	1.85	89.40	29.68	3.62	89.35	2.233	0.502	108.35	17.66	4.63
T_5	33.12	15.28	31.50	7.64	311.29	1.87	98.75	31.55	3.81	98.54	2.463	0.611	111.44	18.17	4.80
T_6	36.18	17.55	33.16	8.07	319.26	1.91	114.18	33.76	4.13	112.77	2.819	0.721	113.20	18.51	5.02
T_7	25.41	11.39	25.26	5.48	254.33	1.74	66.09	23.42	3.24	66.03	1.650	0.259	102.17	16.28	4.44
T_8	28.44	13.61	28.65	6.12	280.43	1.83	76.83	26.13	3.47	76.91	1.922	0.498	106.19	17.42	4.56
T_9	30.54	14.62	30.48	7.40	302.15	1.86	92.36	30.34	3.75	92.80	2.320	0.519	109.61	17.75	4.68
T_{10}	34.35	15.40	31.74	8.04	315.74	1.89	103.64	32.81	3.97	103.16	2.579	0.635	111.73	18.32	4.84
T_{11}	38.69	19.47	34.51	8.13	323.58	1.94	117.52	34.20	4.19	117.42	2.935	0.806	113.58	18.86	5.07
S.Ed(±)	0.33	0.20	0.24	0.07	2.09	0.04	1.24	0.35	0.03	1.28	0.03	0.01	0.68	0.07	0.03
CD at 5%	0.70	0.42	0.51	0.15	4.20	0.08	2.59	0.72	0.06	2.67	0.06	0.02	1.41	0.15	0.07

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