The Pharma Innovation Journal 2023; 12(12): 204-208

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(12): 204-208

www.thepharmajournal.com
Received: 06-09-2023
Accepted: 11-10-2023

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Effect of biodynamic package with biofertilizer and vermicompost on the growth parameters of Radish (*Raphanus sativus*) under Malwa region of Madhya Pradesh

Shikha Aarya, Anvita Sharma, Swati Barche, Pragya Uikey and Vindesh Arya

Abstract
A study was conducted in radish to estimate the Effect of biodynamic package with biofertilizer and vermicompost on the growth parameters of Radish (*Raphanus sativus*)" under Malwa region of Madhya Pradesh". Growth parameters of Radish were studied with respect to number of leaves per plant, leaf length (cm), leaf width (g) and fresh weight of leaf (g), root length (cm) and root width (cm) showed different effect of treatments. The treatment T_{14} (BD 501 @ 5.0 g + Vermicompost @ 2.5 t/ha) was found significantly superior as compare to other treatments character likes number of leaves per plant, leaf length (cm), leaf width (g) and fresh weight of leaf (g), root length (cm) and root width (cm). However, the T_0 (Control) observed minimum as compare to other treatments.

Keywords: Biodynamic, biofertilizer, vermicompost, radish, growth characters

Introduction
Radish (*Raphanus sativus* L.) is an edible root cum leafy vegetable, belongs to family Brassicaceae (Cruciferеae) having chromosome number 2n=18. It is a popular vegetable in India suitable for tropical and temperate climate. In India area and production of Radish is 207 thousand hectare and 3,184 thousand MT with productivity of 15.569 t/ha (NHB 2019-20) [8], while in Madhya-Pradesh, area and production is 10.07 thousand hectare with a production of 152.56 thousand MT respectively, with 14.25 t/ ha productivity Biodynamic (BD) agriculture is the oldest form of ecological agriculture with a history of more than 95 years that is based on the anthroposophical concepts of Rudolf Steiner (Koepf *et al*. 1990) [6]. The biodynamic farming aims to restore humus status of the soil ecosystem to hold its fertility and productivity. Also it helps to restore the soil for a balanced functioning of flora and fauna because soil is a living system where in the microbes can be fully established and maintained.
Vermicompost being rich in organic matter is the commonly used manure to supplement the crops for nutrition. Vermicompost has all characteristic to use it as the most valuable organic manure. Vermicompost is slow releasing organic manure which has most of the macro as well as micronutrients in chelated form and fulfills the nutrients requirement of plant for longer period (Mali *et al*. 2018) [7]. Vermicomposting influences the physio chemical and biological properties of the soil, which, in turn improves the fertility. It is cost effective and renewable source of plant nutrients to supplement the chemical fertilizer
Biofertilizers in combination with organic manures found as effective component in organic farming for reliable and cheap supply of nutrients. These combinations were ecologically safe and improve soil fertility by improving the soil physical, chemical and biological condition. Microbial consortium is a carrier based microbial product that contains N fixing, P & Zn solubilizing and plant growth promoting microbes in single carrier. The Azotobacter and PSB are the main bio-fertilizers which are biologically active products containing bacteria and they improve soil health and fertility. They liberate growth promoting substances and vitamins which may increase crop yield (Sharma *et al*. 2013) [13].

Materials and Methods
The present experiment was laid out in the field of the research farm of Rajmata Vijayarraje Scindia Krishi Vishwa Vidyalaya, Department of Horticulture, College of Agricultur, Indore (M.P.) during 2021-22. The experiment was laid out in the Randomized Block Design with three replications comprised of fourteen treatment combinations.

(T_0 – Control, T_1 - Biodynamic preparation 500 (BD-500) @ 2.5 g/LitreT_2 - Biodynamic preparation 500 (BD-500) @ 5.0 g/Litre, T_3 - Biodynamic preparation 501 (BD-501) @ 2.5 g/Litre, T_4 - Biodynamic preparation 501 (BD-501) @ 5.0 g/Litre, T_5 - *Azotobacter* @ 5 ml/litre, T_6 - Vermicompost @ 2.5 tons/ ha, T_7 - BD 500 @ 2.5 g + *Azotobacter* @ 5 ml/litre, T_8 - BD 500 @ 5.0 g + *Azotobacter* @ 5 ml/litre, T_9 - BD 501 @ 2.5 g + *Azotobacter* @ 5 ml/litre, T_{10} - BD 501 @ 5.0 g + *Azotobacter* @ 5 ml/litre, T_{11} - BD 500 @ 2.5 g + Vermicompost @ 2.5 t/ha, T_{12} - BD 500 @ 5.0 g + Vermicompost @ 2.5 t/ha, T_{13} - BD 501 @ 2.5 g + Vermicompost @ 2.5 t/ha and T_{14} - BD 501 @ 5.0 g + Vermicompost @ 2.5 t/ha. The treatment combinations involving foliar spray of biodynamic preparation (BD 500 & 501), soil drenching with *Azotobacter* and soil application of vermicompost with RDF dose of fertilizers were applied in Radish variety Pusa Chetki. Sampling was done at 30 days up to harvest for growth analysis. Five plants were randomly selected from each treatment and replication for the study. The data based on individual plants selected for observation were statically analyzed as described by (Fisher 1938). The net returns per hectare was worked out for all the treatment by subtracting the cost of cultivation from the gross returns.

Results and Discussion

Growth Parameters

The maximum growth parameters (*viz*., number of leaf per plant, leaf length (cm), leaf width(g) and fresh weight of leaf (g) Root length (cm) and Root Width (cm)) were recorded under treatment T_{14} (BD 501 @ 5.0 g + Vermicompost @ 2.5 t/ha) and it was found the best treatment among other treatments this was closely followed by treatment T_{12} (BD 500 @ 5.0 g + Vermicompost @ 2.5 t/ha). This enhanced growth because of in vermicompost might be due to the presence of more amount of available nitrogen, which is essential for the synthesis of structural proteins. Organic manure, biofertilizers and biodynamic preparation addition also enhanced the vegetative growth of Radish and also acted as stimulate for supply of plant nutrient during the course of microbial decomposition and enabled the crop to utilize nutrient and water more efficiently. These results are supported by the findings of Subramani *et al*. (2011) [14], Jawadagi *et al*. (2012) [4], Sharma *et al*. (2013) [13], Anuja and Vijayalakshmi (2014) [1], Meena *et al*. (2014), Ziaf *et al*. (2015) [15], Randy (2016) [10] and Mali *et al*. (2018) [7].

Yield parameters

The yield index of any crop is expresses the average of the yield of crop which indicated the success or failure of any trial. Yield character of Radish like fresh weight of root (g), ratio of root to leaf (g) marketable yield per hectare (q/ha), biological yield (q/ha), economic yield (q/ha) and harvest index (%) were observed during the investigation.

The result indicated that the maximum yield parameters (*viz*., fresh weight of root, marketable yield per hectare, biological yield and economic yield) were recorded under treatment T_{14} (BD 501 @ 5.0 g + vermicompost @ 2.5 t/ha) and it was found the best treatment combination as compared to other treatment combination for influencing the yield parameters in Radish followed by treatment T_{12} (BD 500 @ 5.0 g + Vermicompost @ 2.5 t/ha). The increased in root weight might be due to the fact that was a positive and significant effect of biodynamic preparation and compost (vermicompost) along with cow dung or inorganic fertilizers on Radish yield. The increased in fresh weight of roots and whole plant may be due to higher level of nitrogen from vermicompost and bio-fertilizers. The results are in confirmation with the results achieved by Chaudhari and Vihol (2011) [2], Patel *et al*. (2011) [9], Eid and El-sayed (2012) [3], Anuja and Vijayalakshmi (2014), Sahu *et al*. (2014) [11], Khalid *et al.* (2015) [5], Ziaf *et al*. (2015) [15] and Randy (2016) [10].

The maximum ratio of root to leaf was found under treatment T_3 (BD 501 (BD-501 @ 2.5 g/Litre). It might be due to increase in weight of roots because of rapid availability and utilization of nitrogen for various internal plant processes for carbohydrate production. Later on these carbohydrates undergo hydrolysis and get converted into reproductive sugars, which ultimately helped in increasing the weight of roots. The favorable effect of organic sources, BD and biofertilizers on microbial activity and root proliferation in soil which caused solubilizing effect on native nitrogen, phosphorus, potassium and other nutrients and organic manures also decreases exploitation of micronutrients. This is in line with the reports of Sentiyangla *et al.* (2010) [12], Subramani *et al.* (2010) [14], Chaudhari and Vihol (2011) [2], Kumar *et al*. (2014), Khalid *et al.* (2015) [5] and Mali *et al.* (2018) [7].

Table 1: Effect of biodynamic package with Biofertilizer and vermicompost on growth parameter

Treatments	No. of leaves /plant	Leaf Length (cm)	Leaf Width (cm)	Fresh Weight of Leaf (g)	Root Length (cm)	Root Width (cm)
T_0	10.91	26.12	9.10	55.21	38.05	4.70
T_1	11.17	27.30	9.46	56.53	39.24	4.84
T_2	11.45	29.84	10.05	60.58	40.65	4.92
T_3	11.24	27.69	9.55	56.87	39.57	4.85
T_4	11.53	30.53	10.10	60.76	40.89	4.99
T_5	11.00	26.54	9.25	55.72	38.40	4.78
T_6	11.09	26.81	9.42	56.05	38.75	4.83
T_7	11.25	28.54	9.65	57.40	39.70	4.87
T_8	11.57	30.70	10.11	61.47	41.00	5.00
T_9	11.31	28.76	9.72	58.52	39.80	4.89
T_{10}	11.63	31.32	10.17	61.88	41.75	5.05
T_{11}	11.37	29.23	9.86	59.53	39.89	4.91
T_{12}	11.67	31.75	10.21	62.33	42.66	5.20
T_{13}	11.40	29.64	9.98	59.78	40.17	4.92
T_{14}	11.70	32.22	10.30	63.42	43.42	5.30
$SE_{m\pm}$	0.042	0.074	0.045	0.073	0.055	0.030
C.D. at 5%	0.121	0.215	0.129	0.211	0.159	0.086

T_1: Biodynamic preparation 500 (BD-500) @ 2.5 g/Litre , T_2: Biodynamic preparation 500 (BD-500) @ 5.0 g/Litre, T_3: Biodynamic preparation 501 (BD-501) @ 2.5 g/Litre, T_4: Biodynamic preparation 501 (BD-501) @ 5.0 g/Litre, T_5: *Azotobacter* @ 5 ml/litre , T_6: Vermicompost @ 2.5 tons/ ha, T_7: BD 500 @ 2.5 g + *Azotobacter* @ 5 ml/litre, T_8: BD 500 @ 5.0 g + *Azotobacter* @ 5 ml/litre, T_9: BD 501 @ 2.5 g + *Azotobacter* @ 5 ml/litre, T_{10}- BD 501 @ 5.0 g + *Azotobacter* @ 5 ml/litre , T_{11} - BD 500 @ 2.5 g + Vermicompost @ 2.5 t/ha, T_{12} - BD 500 @ 5.0 g + Vermicompost @ 2.5 t/ha, T_{13} - BD 501 @ 2.5 g + Vermicompost @ 2.5 t/ha, T_{14} - BD 501 @ 5.0 g + Vermicompost @ 2.5 t/ha and T_0: Control.

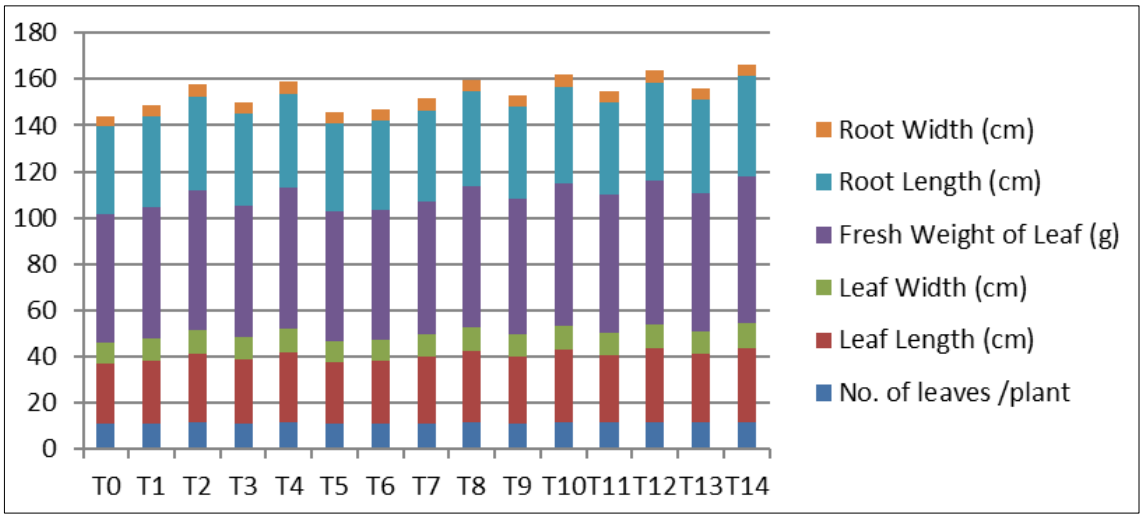

Fig 1: Effect of biodynamic package with Biofertilizer and vermicompost on growth parameter

Table 2: Effect of biodynamic package with Biofertilizer and vermicompost on Yield parameter

Treatments	Fresh Weight of Root (g)	Ratio of Root to leaf	Marketable Yield/ha (q/ha)	Biological Yield (q/ha)	Economical Yield (q/ha)	Harvest Index (%)
T_0	266.10	4.82	514	642.63	532.20	82.82
T_1	271.34	4.80	526	655.74	542.68	82.76
T_2	285.56	4.71	557	692.27	571.11	82.50
T_3	274.68	4.83	533	663.09	549.35	82.85
T_4	288.27	4.74	564	698.07	576.55	82.59
T_5	268.65	4.82	520	648.75	537.31	82.82
T_6	270.28	4.82	523	652.67	540.57	82.82
T_7	275.72	4.80	535	666.23	551.43	82.77
T_8	290.87	4.73	570	704.68	581.73	82.55
T_9	277.67	4.74	540	672.38	555.33	82.59
T_{10}	292.62	4.73	574	708.99	585.23	82.54
T_{11}	279.45	4.69	544	677.97	558.91	82.44
T_{12}	293.63	4.71	579	711.91	587.26	82.49
T_{13}	281.15	4.70	548	681.85	562.29	82.47
T_{14}	295.11	4.65	584	717.06	590.21	82.31
$SE_{m\pm}$	0.254	0.008	0.501	0.493	0.507	0.025
C.D. at 5%	0.734	0.024	1.450	1.429	1.469	0.072

T_1: Biodynamic preparation 500 (BD-500) @ 2.5 g/Litre , T_2: Biodynamic preparation 500 (BD-500) @ 5.0 g/Litre, T_3: Biodynamic preparation 501 (BD-501) @ 2.5 g/Litre, T_4: Biodynamic preparation 501 (BD-501) @ 5.0 g/Litre, T_5: *Azotobacter* @ 5 ml/litre , T_6: Vermicompost @ 2.5 tons/ ha, T_7: BD 500 @ 2.5 g + *Azotobacter* @ 5 ml/litre, T_8: BD 500 @ 5.0 g + *Azotobacter* @ 5 ml/litre, T_9: BD 501 @ 2.5 g + *Azotobacter* @ 5 ml/litre, T_{10}- BD 501 @ 5.0 g + *Azotobacter* @ 5 ml/litre , T_{11} - BD 500 @ 2.5 g + Vermicompost @ 2.5 t/ha, T_{12} - BD 500 @ 5.0 g + Vermicompost @ 2.5 t/ha, T_{13} - BD 501 @ 2.5 g + Vermicompost @ 2.5 t/ha, T_{14} - BD 501 @ 5.0 g + Vermicompost @ 2.5 t/ha and T_0: Control.

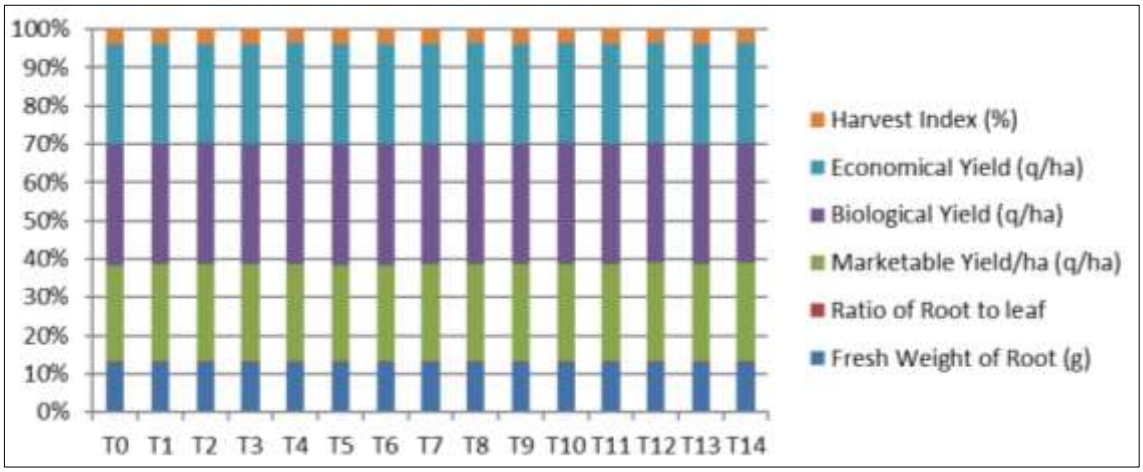

Fig 2: Effect of biodynamic package with Biofertilizer and vermicompost on Yield parameter

Table 3: Effect of biodynamic package with Biofertilizer and vermicompost on Economics of Radish

Treatment Details	Economic parameters		
	Gross income (₹/ha)	Net income (₹/ha)	B:C ratio
T_0	257079	187079	3.7
T_1	262883	191883	3.7
T_2	278694	206694	3.9
T_3	266446	194946	3.7
T_4	281864	208864	3.9
T_5	259760	188160	3.6
T_6	261616	179116	3.2
T_7	267509	194909	3.7
T_8	285059	211459	3.9
T_9	270050	196950	3.7
T_{10}	287047	212447	3.8
T_{11}	271946	188446	3.3
T_{12}	289431	204931	3.4
T_{13}	274118	190118	3.3
T_{14}	292146	206646	3.4

T_1: Biodynamic preparation 500 (BD-500) @ 2.5 g/Litre , T_2: Biodynamic preparation 500 (BD-500) @ 5.0 g/Litre, T_3: Biodynamic preparation 501 (BD-501) @ 2.5 g/Litre, T_4: Biodynamic preparation 501 (BD-501) @ 5.0 g/Litre, T_5: *Azotobacter* @ 5 ml/litre , T_6: Vermicompost @ 2.5 tons/ ha, T_7: BD 500 @ 2.5 g + *Azotobacter* @ 5 ml/litre, T_8: BD 500 @ 5.0 g + *Azotobacter* @ 5 ml/litre, T_9: BD 501 @ 2.5 g + *Azotobacter* @ 5 ml/litre, T_{10}- BD 501 @ 5.0 g + *Azotobacter* @ 5 ml/litre , T_{11} - BD 500 @ 2.5 g + Vermicompost @ 2.5 t/ha, T_{12} - BD 500 @ 5.0 g + Vermicompost @ 2.5 t/ha, T_{13} - BD 501 @ 2.5 g + Vermicompost @ 2.5 t/ha, T_{14} - BD 501 @ 5.0 g + Vermicompost @ 2.5 t/ha and T_0: Control.

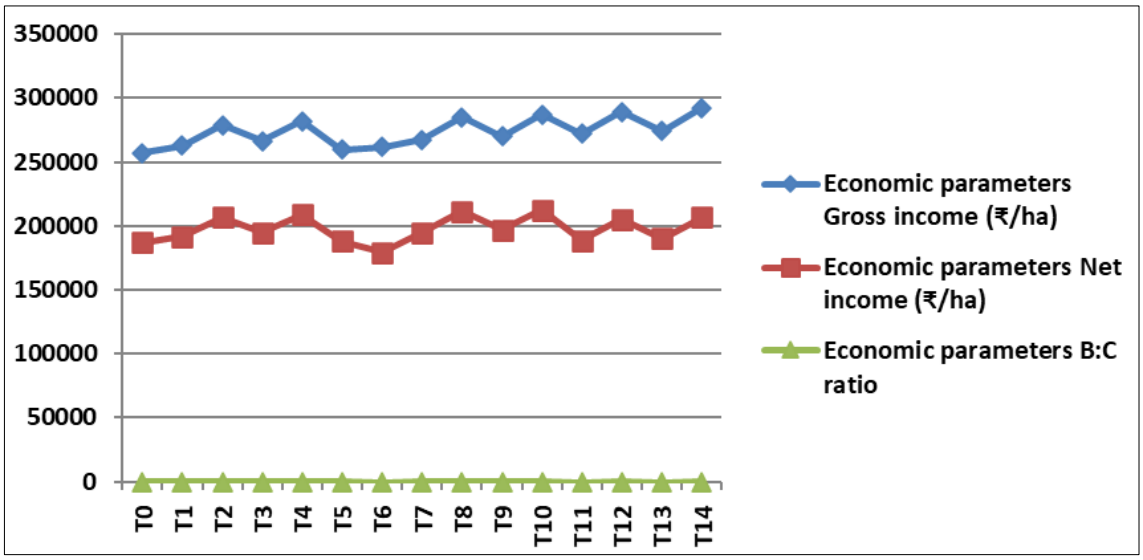

Fig 3: Effect of biodynamic package with Biofertilizer and vermicompost on Economics of Radish

Conclusions

It can be concluded from the result that the different treatment combinations of biodynamic preparation (BD 500 & 501), seed treatment with *Azotobacter* and soil application of vermicompost with RDF dose of fertilizers were significantly influenced the growth, yield and quality parameters of Radish plant. Treatment T_{14} (BD 501 @ 5.0 g + vermicompost @ 2.5 t/ha) was found the best treatment among all the treatments and it gave the maximum growth, yield and quality parameters, while the minimum growth, yield and quality parameters were recorded in treatment T_0 (Control).

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