Biological Forum – An International Journal **14(4): 1306-1308(2022)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Effect of Biodynamic Package with Biofertilizer on Growth, Yield, Quality and Economics of Potato under Malwa condition of Madhya Pradesh

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(Received 26 August 2022, Accepted 29 October, 2022)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: A field experiment was conducted to assess the impact on growth, yield, quality and economics of potato at Research farm, College of Agriculture, Indore (M.P.) during *Rabi* season 2021-2022 in RBD with 3 replications. The yield, productivity and quality parameters are limiting in the potato crop, particularly in the black cotton soil. Hence, the biodynamic package with biofertilizers are attemped to enhance the production, productivity and quality parameters in potato crop. For meet up the demand, 9 treatments *viz.* 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: Azotobactor @ 5 ml/litre, T_6: BD 500@ 2.5 g + Azotobactor @ 5 ml/litre, T_7: BD 500@ 5.0 g + Azotobactor @ 5 ml/litre, T_8: BD 501@ 2.5 g + Azotobactor @ 5 ml/litre, T_9: BD 501 @ 5.0 g + Azotobactor @ 5 ml/litre, and T_0: Control were used The results revealed that combination of azotobacter + biodynamic approach (BD-501) was the best among all the treatments for most of the growth and yield parameters under study and gave highest net return and B: C ratio. Thus, it can be concluded that the biofertlizer (Azotobacter) and biodynamic approach are an advantageous source for sustainable agriculture specially for heavy feeder crops like potato.

Keywords: Biodynamic approach, Biofertilizer, Potato and Sustainable agriculture.

INTRODUCTION

Potato (*Solanum tuberosum* L.) is a versatile, carbohydrate-rich food and highly nutritious, easily digestible, wholesome food containing carbohydrates, protein, minerals, vitamins and high quality dietary fiber. In India area and production of potato is 2.15 Mha and 51.30 Mt with productivity of 23.86 t/ha. While in Madhya Pradesh area and production is 0.18 Mha and 2.69 Mt respectively, with 14.95 t/ha productivity (NHB, 2020-2021).

Being a high yielding and nutrient exhaustive and short duration crop needs higher quantities of fertilizers and pesticides. The low productivity of potato in India as well as in Madhya Pradesh is mainly due to imbalanced utilization or non- utilization of fertilizers/organic manures which does emphasizes the need for judicious and combined application of biofertilizers and organic manures. The biodynamic methods aims to produce well balanced plant growth and sustainble soil fertility by improving the soil structure and nutrient availability. Biofertilizers can play an important role in potato crop which has higher nutrients need because of its sparse root system, it becomes imperative to adopt environment friendly approaches through integrated use of biofertilizer and organic manure in right proportion for ensuring optimum potato yield.

The application of Azotobacter and PSB might have significantly enhanced the availability of native and applied macro and micro nutrients, vitamins, enzymes, antibiotics, growth hormones and insoluble nutrients to the plants, as consequence of which increase the yield of potato tubers and plant. The biofertlizers (azotobacter & phosphobacteria) and biodyanamic inputs area beneficial sources of nutrients for sustainable organic agriculture in potato (Verma *et al.*, 2011). However, the available information on the role of these biofertilizers together with a biodynamic approach in potato is meager. Therefore, an experiment was carried out to examine the effect of biodynamic package with biofertilizer on growth and yield characteristics in potato.

MATERIALS AND METHODS

A field experiment on potato (cv. Kufri Jyoti) was conducted at Research Farm of Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Department of Horticulture, College of Agriculture Indore, during (*Rabi*) 2021-2022 at spacing of 45cm × 30cm in net plot size of 2.25 × 1.8 sq.m. The experimental was conducted in Randomization Block Design with three replications and nine treatments with control, *viz.*, 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: Azotobactor @ 5 ml/litre, T_6: BD 500@ 2.5 g + Azotobactor @ 5 ml/litre, T_7: BD 500@ 5.0 g + Azotobactor @ 5 ml/litre, T_8: BD 501@ 2.5 g + Azotobactor @ 5 ml/litre, T_9: BD 501 @ 5.0 g + Azotobactor @ 5 ml/litre, and T_0: Control.

The calculated quantities of biofertilizer, BD-500 and BD-501 were applied to the respective plot as per the required treatments along with RDF. The ability of microbial culture is harnessed to improve the P availability and increase rate of decomposition of crops' residues, when applied near the root zone of crops consisted of different beneficial microbes. Biodynamic approach, *i.e.* BD 501 @ 2.5 g/ha was sprayed at 2-4 leaf stage in concerned treatments during sunrise. BD-501 works on the photosynthetic process in the leaf. It strengthens the quality of plants and the plant products, and encourages the development of tubers.

Sampling was done at 30 days up to harvest for growth analysis. The growth and yield attributers were recorded on five randomly selected plants in each treatment and replication. The crop was harvested at full maturity and the tubers of each plot were graded in 3 sizes, A, B and C. Gross returns were calculated for different grade size tubers at the current market prize. The net returns per hectare was worked out for all the treatment by subtracting the cost of cultivation from the gross returns. The data were recorded separately and finally subjected to statistical analysis as per methods suggested by Fisher (1938).

RESULTS AND DISCUSSION

Growth and Physiological Parameters. Analysis of variance suggests that all the parameters assessed were significantly affected by the treatments under study. The result revealed that treatment T_9: BD 501 @ 5.0 g + Azotobactor @ 5 ml/litre was found significant superior as compared to rest of treatments in following growth and physiological parameters in different growth stages viz., plant height (28.21), number of leaves/plant (54.25), number of branches/plant (21.55), leaf area (23.67), fresh weight of leaves (52.67) and dry weight of leaves (14.67) which was followed by T_8: BD 501@ 2.5 g + Azotobactor @ 5 ml/litre and T_7: BD 500@ 5.0 g + Azotobactor @ 5 ml/litre (Table 1). This may be due to an increased availability of nutrients to the plant in the presence of biofertilizers and/or biodynamic preparations in these treatments. Azotobacter might have fixed higher amounts of N in soil and therefore, available to the plants resulting in higher uptake of N by plants. BD-501 increases the photosynthetic activity in leaf of plant and shoots growth. These findings are in agreement with those reported earlier by Khan *et al.* (2009); Thilakavathy and Ramaswamy (1999).

Yield and Quality Parameters. Among the different treatments, the maximum yield and quality parameters was recorded in the treatment T_9 : BD 501 @ 5.0 g + Azotobactor @ 5 ml/litre and was found significant superior as compared to rest of treatments in following parameters *viz.,* Number of tubers/plant (9.46), Weight of tubers/plant (449.67), Diameter of tuber (7.93), Tuber yield/plot (13.49), Total tuber yield/ha (333.09) and TSS (6.24) which was followed by T_8: BD 501@ 2.5 g + Azotobactor @ 5 ml/litre and T_7: BD 500@ 5.0 g + Azotobactor @ 5 ml/litre (Table 2). It may be due to the presence of biofertlizer (azotobacter) facilitating higher availability of nutrients in the treatments and increasing different tubers size grades (Gangele *et al*., 2020). It indicates that use of azotobacter with biodynamic approach may increase total tuber yield. BD-501 strengthens the quality of plants and the plant product and encourages the development of tubers. Thus, in the present study, azotobacter with BD-501 increased the number of different size- graded tubers as well as tuber yield. The results confirm the findings of Saxena and Tilak (1994); Ramandeep *et al.* (2018); Singh *et al*. (2017).

Economic feasibility. Higher money value and less cost of cultivation are desirable traits for getting higher returns that there was significant effect of various treatments on the crop economics. Hence, economics of the treatments was worked out. The data pertaining to economics of different treatments are stated in Table 3. It is revealed from the data, that maximum net return of Rs. 475679.88 ha^{-1} with the highest cost benefit ratio of 1:3.54 were found under treatment T_8 : BD 501@ 2.5 g + Azotobactor @ 5 ml/litre. While, lowest net return of Rs. 280069.95 ha^{-1} along with cost benefit ratio of 1: 3.04 was recorded in treatment T_0 (Control). This might be due to higher good quality marketable tuber yield and good market price fetched during selling. Similar result was also reported by Kumar *et al.* (2008); Jayasree and George (2006).

Table 1: Effect of biodynamic package with biofertilizer on growth and physiological parameters.

Treatments	Plant Height (cm)	Number of leaves/plant	Number of branches/ plant	Leaf area (cm^2)	Fresh weight of leaves (g)	Dry weight of leaves(g)
T_0	26.05	51.67	18.46	22.00	49.33	10.67
T_1	27.21	52.67	20.11	22.42	50.33	12.37
T_2	27.27	53.17	20.22	22.67	50.67	12.74
T_3	27.47	53.33	20.53	22.83	51.00	12.75
T_4	27.68	53.50	20.71	22.93	51.33	12.77
T_5	26.22	52.17	19.67	22.17	50.00	11.33
T_6	27.83	53.67	21.00	23.00	51.67	13.00
T_7	27.88	53.93	21.22	23.17	52.00	13.67
T_8	28.18	54.17	21.44	23.33	52.33	14.33
T_9	28.21	54.25	21.55	23.67	52.67	14.67
$SE_{m\pm}$	**1.69**	**2.56**	**1.47**	**1.71**	**1.43**	**3.05**
C.D. at 5%	**4.89**	**7.43**	**4.26**	**4.97**	**4.14**	**8.84**

Table 2: Effect of biodynamic package with biofertilizer on yield and quality parameters.

Treatments	Number of tubers/ plant	Weight of tuber/plant (g)	Diameter of tuber (cm)	Tuber yield/plot (kg)	Tubers yield (q/ha)	TSS (^{0}Brix)
T_0	6.67	281.67	6.33	8.45	208.64	4.20
T_1	8.80	335.00	7.03	10.05	248.15	5.43
T_2	8.94	398.33	7.12	11.95	295.06	5.59
T_3	9.09	398.67	7.55	11.96	295.31	5.72
T_4	9.21	348.33	7.59	10.45	258.02	5.84
T_5	8.78	323.33	6.59	9.70	239.51	5.23
T_6	9.37	430.67	7.65	12.92	319.01	6.07
T_7	9.39	446.67	7.72	13.40	330.86	6.15
T_8	9.43	447.67	7.83	13.43	331.60	6.18
T_9	9.46	449.67	7.93	13.49	333.09	6.24
$SE_{m\pm}$	**0.53**	**88.32**	**0.04**	**2.65**	**65.42**	**0.13**
C.D. at 5%	**1.54**	**255.86**	**0.12**	**7.68**	**189.52**	**0.39**

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: Azotobactor @ 5 ml/litre, T_6: BD 500@ 2.5 g + Azotobactor @ 5 ml/litre, T_7: BD 500@ 5.0 g + Azotobactor @ 5 ml/litre, T_8: BD 501@ 2.5 g + Azotobactor @ 5 ml/litre, T_9: BD 501 @ 5.0 g + Azotobactor @ 5 ml/litre, and T_0: Control

Table 3: Economics of various treatments.

Treatment	Yield (q/ha)	Gross income (Rs. /ha)	Expenditure (Rs./ha)	Net income (Rs./ha)	C:B Ratio
T_0	208.64	417283.95	137214.00	280069.95	1:3.04
T_1	248.15	496296.30	161905.00	334391.30	1:3.07
T_2	295.06	590123.46	186596.00	403527.46	1:3.16
T_3	295.31	590617.28	180530.00	410087.28	1:3.27
T_4	258.02	516049.38	161905.00	354144.38	1:3.19
T_5	239.51	479012.35	156630.00	322382.35	1:3.06
T_6	319.01	638024.69	188530.00	449494.69	1:3.38
T_7	330.86	661728.40	185530.00	476198.40	1:3.57
T_8	331.60	663209.88	187530.00	475679.88	1:3.54
T_9	333.09	666172.84	190530.00	475642.84	1:3.50

CONCLUSION

According to the findings of the research, the combined application of BD-501 + Azotobacter may be the best approach among all treatments for increasing tuber yield and thus economic return for the farmer. Biofertilizers (Azotobacter) and biodyanamic inputs are beneficial sources of nutrients for sustainable organic agriculture in crops requiring high amounts of nutrients, such as potatoes.

FUTURE SCOPE

The results of the present study will be used to develop other technological sequences for the cultivation of potatoes in malwa region of Madhya Pradesh. In the future, we will focus on the specific climate and soil conditions, the irrigation system, weed control and effective mulching parameters. Furthermore, it is suggested to conduct multi-location and multi-seasonal trials on this aspect to achieve more accurate results.

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How to cite this article: Priyanka Gaware, Swati Barche, Anvita Sharma, Veena Rathore and Shailendra Singh Yadav (2022). Effect of Biodynamic Package with Biofertilizer on Growth, Yield, Quality and Economics of Potato under Malwa Condition of Madhya Pradesh. *Biological Forum – An International Journal*, *14*(4): 1306-1308.