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IMPACT OF FYM, VERMICOMPOST AND BIO-FERTILIZERS ON GROWTH, YIELD AND QUALITY OF POTATO (*SOLANUM TUBEROSUM* L.)

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ABSTRACT

The present investigation entitled "Impact of FYM, vermicompost and bio-fertilizers on growth, yield and quality of potato (*Solanum tuberosum* L.)" was conducted at Research farm, School of Agriculture, ITM University, Gwalior M.P. during Rabi 2019-20 under agro-climatic and soil conditions of Northern Madhya Pradesh. Potato (*Solanum tuberosum* L.) is one of the most important vegetable crops widely grown in the world. It belongs to the family Solanaceae and considered to be originated in South America. The trend of organic farming is getting momentum because people prefer to consume vegetable free from chemical residues. Application of organic sources in conjunction with fertilizers ensures organic agriculture is a holistic production management system which promotes and enhances agro-ecosystem health, including bio-diversity, biological cycles and soil-biological activity. Bio-fertilizers containing beneficial bacteria and fungi improve soil chemical and biological characteristics, phosphate solubility and agricultural production. Bio-fertilizers have improved quantity and quality features of some plants. The experiment was laid out in the Randomized Block Design with three replications. Each replication was comprised of eleven treatment combinations of vermicompost, *Azotobacter* and PSB with different RDF dose of fertilizers were applied before planting in potato variety Kufri Soga. Results showed that the treatment T8 (75% RDF + 25% Vermicompost + *Azotobacter*+ PSB) is the best treatment of vermicompost, *Azotobactor* and PSB with different RDF dose of fertilizers. It was significantly influenced the morphological, yield and quality parameters as well as economic parameters of potato. The maximum morphological and yield parameters were recorded in treatment T8 (75% RDF + 25% Vermicompost + *Azotobacter*+ PSB), whereas the minimum morphological and yield parameters were recorded in treatment T4 (50% RDF + 25% FYM + 25% Vermicompost).
Keywords **:** FYM, Vermicompost, Biofertilizers, Organic manure.

Introduction

Potato (*Solanum tuberosum* L.) is one of the most important vegetable crops widely grown in the world. It belongs to the family *Solanaceae* and considered to be originated in South America. The trend of organic farming is getting momentum because people prefer to consume vegetable free from chemical residues. The organic manures not only supply the nutrients but also improve the physical environment for better plant and tuber growth. The manures are low analysis nutrient carriers yet play a significant role in the fertilizer economy. Application of organic sources in conjunction with fertilizers ensures organic agriculture is a holistic production management system which promotes and enhances agro-ecosystem health, including bio-diversity, biological cycles and soil- biological activity. Bio-fertilizers containing beneficial bacteria and fungi improve soil chemical and biological characteristics, phosphate solubility and agricultural production (El-Habbasha *et al.,* 2007). Bio-fertilizers have improved quantity and quality features of some plants (Yosefi *et al.,* 2011).

Materials and Methods

The experiment was laid out in the Randomized Block Design with three replications and each replication was comprised of eleven treatment combinations (i.e. T1 – 100%RDF (Dose/ha), T2 –75% RDF + 25% FYM, T3 – 75% RDF + 12.5% FYM + 12.5% Vermicompost, T4 –50% RDF + 25% FYM + 25% Vermicompost, T5 –75% RDF + 12.5% FYM + 12.5% Vermicompost +*Azotobacter*, T6 – 75% RDF + 12.5% FYM + 12.5% Vermicompost + PSB, T7 – 75% RDF + 25% FYM +*Azotobacter* + PSB, T8 –75% RDF + 25% Vermicompost + *Azotobacter* + PSB, T9 – 50%RDF + 12.5% FYM +12.5% Vermicompost + *Azotobacter* + PSB, T10 – 75%RDF + 25% FYM + PSB and T11 –75%RDF + 25% Vermicompost + *Azotobacter*) were applied before planting in potato variety Kufri Soga.

Result and Discussion

Morphological parameters

It was evident from the result that the treatment T8 (75% RDF + 25% Vermicompost + *Azotobacter*+ PSB) is significantly superior to other dose of organic manures and biofertilizers with different levels of RDF and had significant effect on morphological parameters of potato. The maximum morphological parameters (viz., plant height at 60 DAP, number of compound leaves per plant at 60 DAP, fresh weight of shoots per plant (g), dry weight of shoots per plant, diameter of stem (cm) at 60 DAP and number of haulms per plant at 60 DAP) were recorded under treatment T8 (75% RDF + 25% Vermicompost + *Azotobacter*+ PSB) and it was found significantly superior to other treatments and the minimum morphological parameters were found in treatment

T4 (50% RDF + 25% FYM + 25% Vermicompost), respectively. While the minimum days required for emerging plant was recorded under treatment T8 (75% RDF + 25% Vermicompost + *Azotobacter*+ PSB) and the maximum days required for emerging plant was recorded in treatment T4 (50% RDF + 25% FYM + 25% Vermicompost). This could be due presence of enzymes, hormones, growth regulators along with plant nutrients in vermicompost while Azotobactor and PSB are biofertilizers which improves the nutrient up take and provide better condition for plant growth. Vermicompost promoting growth by enhanced biosynthesis and accumulation of proteins, amino acids and enzymes which are responsible for cell division and cell elongation thus resulted in improvement in length and width of leaves and diameter of stem. Azotobactor and PSB are improves the availability of nitrogen and phosphorus by nitrogen fixation and phosphorus solubilization. Similar results for most of the characters were also reported by Jaipaul *et al*. (2011), Kumar *et al.* (2015), Singh *et al.* (2017), Koodi *et al.* (2017), Brijesh *et al.* (2017), Ramandeep *et al*. (2018), Ali *et al.* (2019), Saxena and Singh (2020) and Gangele *et al.* (2020).

Yield parameters

The investigation revealed that the treatment T8 (75% RDF + 25% Vermicompost + *Azotobacter*+ PSB) is the best application of organic manure and biofertilizers with different level of RDF. The maximum yield parameters (viz., tubers yield per plot (kg), per hectare (q), number of tubers per plant at harvest, average diameter of tubers per plot and average tuber weight per plot) were found in treatment T8 (75% RDF + 25% Vermicompost + *Azotobacter*+ PSB) and it was significantly superior to other treatments while the minimum yield parameters were recorded in treatment T4 (50% RDF + 25% FYM + 25% Vermicompost). The application of vermicompost, Azotobactor 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. Tuber yield was influenced to great extent by growth, nutrient and moisture supply. The increase in yield with the application of vermicompost, Azotobactor and PSB could be attributed to corresponding increase in leaf area and insoluble nutrients to soluble form, which was responsible for synthesizing photosynthate and increase in number and weight of tuber. The results are in confirmation with the results achieved by Narayan *et al.* (2013), Sharma *et al*. (2015),

Quality parameters

The result revealed that the treatment T8 (75% RDF + 25% Vermicompost + *Azotobacter*+ PSB) is significantly superior to other dose of organic manures and biofertilizers with different levels of RDF and had significant effect on quality parameters of potato. The maximum quality parameters (viz., dry matter content per 100g of edible portion, TSS at harvest and starch content of tubers at harvest) were observed in treatment T8 (75% RDF + 25% Vermicompost + *Azotobacter*+ PSB) and it was significantly superior to other treatments. However, the minimum quality parameters were observed in treatment T4 (50% RDF + 25% FYM + 25% Vermicompost). It might be due to application of vermicompost, Azotobacter and PSB that played a positive role in affecting quality parameters of potato like dry matter content, TSS and starch content. The highest tuber TSS content might be due to maximum moisture content, dry weight of tuber because organic fertilizers carry almost all micro and macro nutrients that are required for the plants growth and the continued application of vermicompost increase photosynthesis of plant and due to enhancement of photosynthesis, sugar, starch and cellulose synthesis might have improved. These results are supported by the findings of Prasad (2010), Jaipaul *et al*. (2011), Abdel and Shams (2012), Bhat *et al.* (2017), Koodi *et al.* (2017), Islam *et al.* (2017), Brijesh *et al.* (2017), Ram *et al.* (2017) and Gangele *et al.* (2020).

Economics parameters

Results showed that that treatment T8 (75% RDF + 25% Vermicompost + *Azotobacter*+ PSB) is the best application of organic manure and biofertilizers with different level of RDF and had significant effect on economical yield of potato. The maximum cost of cultivation (≠/ha), gross income (≠/ha), net income (≠/ha) and B:C was recorded in treatment T8 (75% RDF + 25% Vermicompost + *Azotobacter*+ PSB). However, the minimum cost of cultivation (≠/ha) was recorded in treatment T1 (100% RDF (Dose/ha)), while minimum gross income (≠/ha), net income (≠/ha) and B:C was recorded in treatment T4 (50% RDF + 25% FYM + 25% Vermicompost). Findings are in agreement with those of Verma *et al.* (2010), Verma *et al*. (2011), Kumar *et al*. (2011) and Gangele *et al.* (2020).

Conclusion

It can be concluded from the result of present investigation that huge variation was noticed among the different treatment studied in this investigation for all the morphological parameters, yield parameters and quality parameters as well as economic parameters of potato. Results showed that the treatment T8 (75% RDF + 25% Vermicompost + *Azotobacter*+ PSB) is the best treatment of vermicompost, *Azotobactor* and PSB with different RDF dose of fertilizers. It was significantly influenced the morphological, yield and quality parameters as well as economic parameters of potato. The maximum morphological and yield parameters were recorded in treatment T8 (75% RDF + 25% Vermicompost + *Azotobacter*+ PSB), whereas the minimum morphological and yield parameters were recorded in treatment T4 (50% RDF + 25% FYM + 25% Vermicompost).

Table 1: Effect of organic fertilizer and biofertilizer on morphological parameters of potato.

Treatment Details	Days required for emerging plant	Plant height (cm) at 60 DAP	Number of compound leaves per plant at 60 DAP	Fresh weight of shoots per plant (g)	Dry weight of shoots per plant (g)	Diameter of stem (cm) at 60 DAP	Number of haulms per plant at 60 DAP
T1 –100% RDF (Dose/ha)	8.26	46.36	7.38	183.04	27.23	11.61	7.48
T2 –75% RDF + 25% FYM	11.86	37.40	5.73	171.85	21.90	7.54	5.73
T3 –75% RDF + 12.5% FYM + 12.5% Vermicompost	10.51	39.93	6.11	172.41	22.23	8.32	6.11
T4 –50% RDF + 25% FYM + 25% Vermicompost	13.28	33.24	5.09	165.12	20.08	6.58	5.09
T5 –75% RDF + 12.5% FYM + 12.5% Vermicompost +*Azotobacter*	7.65	47.41	7.77	185.57	28.63	12.51	7.82
T6 – 75% RDF + 12.5% FYM + 12.5% Vermicompost + PSB	9.67	42.08	6.86	175.11	24.67	9.98	7.01
T7 – 75% RDF + 25% FYM +*Azotobacter* + PSB	8.60	45.33	7.21	182.09	26.32	11.09	7.26
T8 –75% RDF + 25% Vermicompost + *Azotobacter*+ PSB	6.93	48.08	8.16	188.08	29.09	13.06	8.28
T9 – 50% RDF + 12.5% FYM +12.5% Vermicompost + *Azotobacter* + PSB	12.45	34.24	5.59	167.31	21.05	6.95	5.59
T10 – 75% RDF + 25%FYM + PSB	10.30	41.47	6.62	174.33	24.16	9.15	6.62
T11 –75% RDF + 25% Vermicompost + *Azotobacter*	8.69	43.42	7.10	179.18	25.38	10.76	7.21
SEm ±	**0.255**	**0.578**	**0.505**	**0.921**	**0.481**	**0.244**	**0.511**
CD 5%	**0.753**	**1.706**	**1.491**	**2.716**	**1.419**	**0.721**	**1.509**

Table 2: Effect of organic fertilizer and biofertilizer on yield parameters of potato.

Treatment Details	Tuber yield per plot (kg)	Tuber yield per hectare (q)	Number of tubers per plant at harvest	Average diameter of tubers (cm) per plot at harvest	Average tuber weight (g) per plot
T1 –100% RDF (Dose/ha)	29.87	358.46	10.54	5.62	56.72
T2 –75% RDF + 25% FYM	16.41	196.88	7.17	4.59	45.78
T3 –75% RDF + 12.5% FYM + 12.5% Vermicompost	17.55	210.62	7.48	4.78	46.94
T4 –50% RDF + 25% FYM + 25% Vermicompost	12.86	154.28	6.12	4.07	42.62
T5 –75% RDF + 12.5% FYM + 12.5% Vermicompost +*Azotobacter*	30.52	366.19	10.72	6.16	57.05
T6 – 75% RDF + 12.5% FYM + 12.5% Vermicompost + PSB	22.16	265.91	8.90	5.14	49.80
T7 – 75% RDF + 25% FYM +*Azotobacter* + PSB	25.70	308.36	9.59	5.54	53.60
T8 –75% RDF + 25% Vermicompost + *Azotobacter*+ PSB	32.57	390.88	11.22	6.28	58.66
T9 – 50% RDF + 12.5% FYM +12.5% Vermicompost + *Azotobacter* + PSB	14.15	169.78	6.51	4.49	43.46
T10 – 75% RDF + 25%FYM + PSB	20.02	240.28	8.26	5.05	48.50
T11 –75% RDF + 25% Vermicompost + *Azotobacter*	24.06	288.78	9.30	5.44	51.80
SEm ±	**1.397**	**16.765**	**0.570**	**0.152**	**0.457**
CD 5%	**4.121**	**49.457**	**1.683**	**0.450**	**1.349**

Table 3: Effect of organic fertilizer and biofertilizer on quality parameters of potato.

Treatment Details	Dry matter content per 100g of edible portion	TSS (^{0}Brix) at harvest	Starch content (%) of tubers at harvest
T1 –100% RDF (Dose/ha)	22.42	4.78	18.67
T2 –75% RDF + 25% FYM	20.13	4.62	16.18
T3 –75% RDF + 12.5% FYM + 12.5% Vermicompost	20.35	4.63	16.93
T4 –50% RDF + 25% FYM + 25% Vermicompost	19.75	4.60	15.56
T5 –75% RDF + 12.5% FYM + 12.5% Vermicompost +*Azotobacter*	22.93	4.79	19.71
T6 – 75% RDF + 12.5% FYM + 12.5% Vermicompost + PSB	20.62	4.69	17.98
T7 – 75% RDF + 25% FYM +*Azotobacter* + PSB	21.44	4.74	18.32
T8 –75% RDF + 25% Vermicompost + *Azotobacter*+ PSB	23.71	4.90	20.47
T9 – 50% RDF + 12.5% FYM +12.5% Vermicompost + *Azotobacter* + PSB	19.90	4.62	16.08
T10 – 75% RDF + 25%FYM + PSB	20.54	4.69	17.55
T11 –75% RDF + 25% Vermicompost + *Azotobacter*	21.04	4.74	18.21
SEm ±	**0.264**	**0.052**	**0.238**
CD 5%	**0.778**	**0.153**	**0.703**

Table : Economics of the treatments

Treatment Details	Cost of cultivation (≠/ha)	Gross income (≠/ha)	Net income (≠/ha)	B:C ratio
T1 –100% RDF (Dose/ha)	117000	376380	259380	3.2
T2 –75% RDF + 25% FYM	120000	236253	116253	2.0
T3 –75% RDF + 12.5% FYM + 12.5% Vermicompost	123250	252743	129493	2.1
T4 –50% RDF + 25% FYM + 25% Vermicompost	129500	185132	55632	1.4
T5 –75% RDF + 12.5% FYM + 12.5% Vermicompost +*Azotobacter*	124750	439430	314680	3.5
T6 – 75% RDF + 12.5% FYM + 12.5% Vermicompost + PSB	125050	319095	194045	2.6
T7 – 75% RDF + 25% FYM +*Azotobacter* + PSB	123300	370031	246731	3.0
T8 –75% RDF + 25% Vermicompost + *Azotobacter*+ PSB	129800	469059	339259	3.6
T9 – 50% RDF + 12.5% FYM +12.5% Vermicompost + *Azotobacter* + PSB	123550	203741	80191	1.6
T10 – 75% RDF + 25%FYM + PSB	121800	288333	166533	2.4
T11 –75% RDF + 25% Vermicompost + *Azotobacter*	128000	346532	218532	2.7

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