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Effect of growth parameters as influenced by nutrient sources of Potato (*Solanum tuberosum* L.)

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Abstract
The present investigation entitled Effect of growth parameters as influenced by nutrient sources of potato (*Solanum tuberosum* L.) was carried out in Horticulture Research cum Instructional Farm of Barrister Thakur Chhedilal College of Agriculture and Research Station, Sarkanda, Bilaspur (C.G.), during Rabi season of Nov 2018 to Mar 2019, The field experiment was laid out in randomized block design with 3 replications and 12 different treatment combinations viz. T1 (125% RDF (187:125:125 kg ha-1 NPK), T2 (100% RDF (150:100:100 kg ha-1 NPK), T3 (75% RDF + FYM @ 7.5 t ha-1(25% N by FYM), T4 (50% RDF + FYM @ 15 t ha-1(50% N by FYM), T5 (75% RDF + Vermicompost @ 3.75 t ha-1 (25% N by Vermicompost), T6 (50% RDF + Vermicompost @ 7.5 t ha-1 (50% N by Vermicompost), T7 (Tuber treatment with Trichoderma @ 20 g /k + soil incorporation of Trichoderma enriched FYM @ 15 t ha-1 SOIL, T8 (Tuber treatment with Pseudomonas @ 20 g /k + soil incorporation of Pseudomonas enriched FYM @ 15 t ha-1 soil, T9 (Tuber treatment with Pseudomonas followed by Trichoderma @ 20 g /k + soil incorporation of consortia of Pseudomonas & Trichoderma enriched FYM @ 15 t ha-1 soil, T10 (Tuber treatment with consortia of Azotobacter & PSB @20 g /k + soil incorporation of consortia of Azotobacter & PSB enriched FYM @ 15 t ha-1 soil, T11 (50% RDF only FYM @ 15 t ha-1 (50% N by FYM) and T12 (Local control). Integrated use of synthetic fertilizers and organic manures showed the significant impact on growth of potato. Among the different treatments, application of T6- (50% RDF + Vermicompost @ 7.5 t ha-1 (50% N by Vermicompost) had resulted in higher plant height (44.13 cm), number of green leaves and number of shoots per plant (66.40 and 4.37 respectively), and crop growth rate (2.17g/m2/day,) fresh tuber weight per plant (145.67 g), and number of tuber late per plant (18.67), 70 & 90 DAS and at harvest, respectively) was noticed in case of 50% RDF + Vermicompost @ 7.5 t ha-1 (50% N by Vermicompost).

Keywords: azotobacter, ferttilizer, vermicompost, yield, FYM, biofertilizer, NPK

Introduction
Potato (*Solanum tuberosum* L.) is one of the most important basic vegetable and staple food-crop of the world as well as Indian continents which belong to family solanaceae. Potato is world's fourth important food crop after wheat, rice and maize (Rana, M.K. 2008). More than a billion people worldwide eat potato, the potato is the third most important food crop in the world after rice and wheat in terms of human consumption, it is originated from Andes of Peru in South America.

It is introduced in India in early 17th centuries either by Portuguese or the Britishers which is grown throughout the country commercially from sea level to temperate region (upto 4000 MSL). Potato is one of the value added and exportable items. The widely grown potato is an autotetraploid with 2n=48. The potato is unique and different from other crops in that sense the food material is stored in underground stem parts called tubers. Potato provides a source of low cost energy to the human diet and it is the rich source of starch, vitamin C and B and minerals (Kumar *et al*., 2013; Lokendrajit *et al*., 2013). It is a heavy feeder of plant nutrients having very high requirement of nitrogen, phosphorus, potassium and other nutrients. Potato is known as protective food because potato protein is rich in lysine which is one of the most important amino acid. The potato is a highly nutritious, easily digestible, wholesome food which contains 77.20 % water and the rest is dry matter. Average dry matter composition is 16.30% starch, 0.9% sugar (0.6 total sugar and 0.3 reducing sugar), 4.40% protein (2.8% crude and 1.60% true protein), 0.9% minerals, 0.59% fiber, 0.14% crude fat and considerable amount of vitamin A and C (Bose, 1993).

Potato is high yielding and more nutrient required crop. The growth, development and yield of potato are mainly governed by nutrient availability through major nutrients. Nitrogen, phosphorus and potassium are major nutrients required for cultivation of potato. Nitrogen is a constituent of protoplasm and it is helpful for chlorophyll synthesis. Phosphorus increases the growth of shoots, roots and tuber formation in potato. Whereas, potassium help to provide resistance against diseases and pests. There are many sources of nitrogen, phosphorus and potassium through organic fertilizers

Material and Methods
A field experiment was conducted at the Horticulture Research cum Instructional Farm of Barrister Thakur Chhedilal College of Agriculture and Research Station, Sarkanda, Bilaspur (C.G.), during Rabi season of 2018, to study "Effect of integrated nutrient management on growth and yield of potato (*Solanum tuberosum* L.)*"* The details of the materials used and methods adopted during the course of investigation are described in this chapter.

During the crop period the maximum temperature varies between 22.43 °C to 31.54 °C whereas, minimum temperature ranges between 6.94 °C to 15.17 °C .The maximum and minimum relative humidity varied between 97.00 to 38.43 per cent respectively. Evaporation recorded between 1.57 to 4.01 mm per day. The soil of experimental site was alluvium soil & vertisol belonging to textural class clay. The experiment consisted of the following treatments involving organics viz., Farmyard manure, vermicompost and biofertilizers (applied before planting) in different percentage to substitute the recommended dose of fertilizer on nitrogen basis. The recommended fertilizer dose for potato is 150:100:100 kg NPK ha-1, well decomposed farm yard manure and vermicompost containing 0.5 and 2.5 % N; 0.2 and 2.5 % P O; 0.5 and 0.6 % K O, respectively were incorporated in the soil. Half dose of nitrogen and full dose of phosphorus and potassium through urea, single supper phosphate and muriate of potash were applied as basal dressing. The remaining half dose of nitrogen was top dressed at first earthing up operation. Observations were recorded on crop growth parameters Plant emergence was recorded viz., Initial and final plant population, Plant height (cm) - 30, 50 and 70 DAS, Number of green leaves, per plant - 30, 50 and 70 DAS, Number of shoots per plant - 30, 50 and 70 DAS, Crop Growth Rate (CGR) at- 30, 60 and 90 DAS, Fresh weight per plant at- 30, 60 and 90 DAS, Number of tuber late per plant at - 30, 60 and 90 DAS, as influenced by effect of integrated nutrient management are presented here under.

Results and Discussion

Since the potato crop has developed poorly and the demand for nutrients in the shallow root system is high. Selection of the proper nutrient source is necessary to meet the demand of crop nutrients. in the present study most of the growth parameters viz., Initial and final plant population, Plant height (cm) - 30, 50 and 70 DAS, Number of green leaves, per plant - 30, 50 and 70 DAS, Number of shoots per plant - 30, 50 and 70 DAS, Crop Growth Rate (CGR) at- 30, 60 and 90 DAS, Fresh weight per plant at- 30, 60 and 90 DAS, Number of tuber late per plant at - 30, 60 and 90 DAS were significantly influenced by nutrients sources.

Initial and final plant population

It was observed that Initial and final plant population was similar and non-significantly result in plant population. The treatments failed to cause significant variations in the plant population as recorded 30 DAS and at the time of harvest, given the table: 4.1. & fig (4.1).

Plant height (cm)

It was observed that highest in the plots treated with T6- (50% RDF + Vermicompost @ 7.5 t ha-1 (50% N by Vermicompost) (31.67 cm & 38.97) and (44.13) at 30 & 50 and 70 DAS, respectively followed by T1 (125% RDF (187:125:125 kg ha-1 NPK) (30.00 & 35.80 cm) and (41.30 cm) at 30 & 50 and 70 DAS, respectively., It is evident from the data that the growth of potato in terms of plant height varied significantly due to integrated nutrient management, chemical fertilizers and organic manure, during all the stages of crop growth except at 30 & 50 and 70 DAS given the table 4.1& fig 4.2. The results obtained in the present study are supported by the findings of Kumar *et al.* (2011) [2], Haque *et al*., (2007) and Alam *et al*., (2007) in potato.

Number of green leaves per plant

It was observed that highest in the plots treated with T6- (50% RDF + Vermicompost @ 7.5 t ha-1 (50% N by Vermicompost) (117.60 & 155.73) and (66.40) at 30 & 50 and 70 DAS, respectively followed by T1 (125% RDF (187:125:125 kg ha-1 NPK) (113.73 & 151.30) and (62.57) at 30 & 50 and 70 DAS, respectively., It is evident from the data that the growth of potato in terms of Number of green leaves per plant varied significantly due to integrated nutrient management, chemical fertilizers and organic manure, during all the stages of crop growth except at 30 & 50 and 70 DAS given the Table 4.1 & fig 4.3 The results obtained in the present study are supported by the findings of Singh and Chauhan *et al*., (2014) and in potato.

Crop growth rate

It was observed that highest in the 30 DAS plots treated with T5- (75% RDF + Vermicompost @ 3.75 t ha-1 (25% N by Vermicompost) (1.95 g/m²/day) at, and 60 DAS plots treated with T8 (Tuber treatment with Pseudomonas @ 20 g /k + soil incorporation of Pseudomonas enriched FYM @ 15 t ha-1 soil) (3.17 g/m²/day), and 90 DAS plots treated with T10 (Tuber treatment with consortia of Azotobacter & PSB @20 g /k + soil incorporation of consortia of Azotobacter & PSB enriched FYM @ 15 t ha-1 soil) (3.13 g/m²/day), respectively followed by T1 (125% RDF (187:125:125 kg ha-1 NPK) (1.76 & 2.99 g/m²/day) and (2.73 g/m²/day) at 30 & 60 and 90 DAS, respectively., It is evident from the data that the growth of potato in terms of Crop growth rate varied significantly due to integrated nutrient management, chemical fertilizers and organic manure & biofertilizers, during all the stages of crop growth except at 30 & 60 and 90 DAS given the table 4.2 & fig 4.4. The results obtained in the present study are supported by the findings of Shankaran and Subbaiah *et al*., (1997) & (Edward *et al*., 2000). Atiyeh *et al*., (2000) & Mondal *et al*., (1993) & Taya *et al*., (1994) in potato.

Number of shoots per plant

It was observed that highest in the plots treated with T6- (50% RDF + Vermicompost @ 7.5 t ha-1 (50% N by Vermicompost) (5.83 & 6.03) and (4.37) at 30 & 50 and 70 DAS, respectively followed by T1 (125% RDF (187:125:125 kg ha-1 NPK) (5.53 & 5.80) and (3.90) at 30 & 50 and 70 DAS, respectively., It is evident from the data that the growth of potato in terms of number of shoots per plant varied significantly due to integrated nutrient management, chemical fertilizers and organic manure, during all the stages of crop growth except at 30 & 50 and 70 DAS given the table 4.2& fig 4.5. The results obtained in the present study are supported by the findings of Mandal and Arora *et al*., (1978) & Singh and Chauhan *et al*., (2014) in potato.

Fresh weight per plant

It was observed that highest in the plots treated with T6- (50% RDF + Vermicompost @ 7.5 t ha-1 (50% N by Vermicompost) (61.67 g & 211.67 g) and (145.67 g) at 30 &

60 and 90 DAS, respectively followed by T1 (125% RDF (187:125:125 kg ha-1 NPK) (59.67 g & 189.33 g) and (138.67 g) at 30 & 60 and 90 DAS, respectively., It is evident from the data that the growth of potato in terms of fresh weight per plant varied significantly due to integrated nutrient management, chemical fertilizers and organic manure, during all the stages of crop growth except at 30 & 60 and 90 DAS given the table 4.2 & fig 4.6 The results obtained in the present study are supported by the findings of Alam *et al*. (2007) in potato.

Number of tuber late per plant

It was observed that highest in them plots treated with T6- (50% RDF + Vermicompost @ 7.5 t ha-1 (50% N by Vermicompost) (8.33 & 13.33) and (18.67) at 30 & 60 and 90 DAS, respectively followed by T1 (125% RDF (187:125:125 kg ha-1 NPK) (7.33 & 12.67) and (17.33) at 30 & 60 and 90 DAS, respectively., It is evident from the data that the growth of potato in terms of number of tuber late per plant varied significantly due to integrated nutrient management, chemical fertilizers and organic manure, during all the stages of crop growth except at 30 & 60 and 90 DAS given the table 4.2 & fig 4.7. The results obtained in the present study are supported by the findings of Behjati *et al*., (2013) [1] & Sharif Hossain *et al*., (2003) & Kumar and Sharma *et al*., (2002) in potato.

Table 1: Effect of growth parameters as influenced by nutrient sources of potato

Trt. No.	Treatment Details	Plant population		Plant height (cm^2)			Number of green leaves per plant		
		At 30 DAS	At harvest	30 DAS	50 DAS	70 DAS	30 DAS	50 DAS	70 DAS
T_1	125% RDF (187:125:125 kg ha^{-1} NPK)	41.67	40.67	30.00	35.80	41.30	113.73	151.30	62.57
T_2	100% RDF (150:100:100 kg ha^{-1} NPK)	41.00	40.00	23.13	28.33	35.40	94.57	135.27	38.93
T_3	75% RDF + FYM @ 7.5 t ha^{-1}(25% N by FYM)	40.67	39.67	20.00	28.07	37.00	84.10	109.53	37.53
T_4	50% RDF + FYM @ 15 t ha^{-1}(50% N by FYM)	40.67	39.67	20.77	29.03	36.13	97.33	110.87	44.60
T_5	75% RDF + Vermicompost @ 3.75 t ha^{-1} (25% N by Vermicompost)	39.67	38.67	20.07	28.87	33.90	84.13	139.60	46.40
T_6	50% RDF + Vermicompost @ 7.5 t ha^{-1} (50% N by Vermicompost)	42.00	41.67	31.67	38.97	44.13	117.60	155.73	66.40
T_7	Tuber treatment with Trichoderma @ 20 g /k + soil incorporation of Trichoderma enriched FYM @ 15 t ha^{-1} soil	40.00	39.33	21.80	29.00	34.27	97.80	132.40	42.13
T_8	Tuber treatment with Pseudomonas @ 20 g /k + soil incorporation of Pseudomonas enriched FYM @ 15 t ha^{-1} soil	40.00	38.33	20.27	27.07	30.73	94.33	132.40	34.67
T_9	Tuber treatment with Pseudomonas followed by Trichoderma @ 20 g /k + soil incorporation of consortia of Pseudomonas & Trichoderma enriched FYM @ 15 t ha^{-1} soil	40.33	40.00	21.60	27.07	30.00	75.67	128.80	52.80
T_{10}	Tuber treatment with consortia of Azotobacter & PSB @20 g /k + soil incorporation of consortia of Azotobacter & PSB enriched FYM @ 15 t ha^{-1} soil	41.33	40.33	24.97	30.40	38.93	102.27	144.57	58.90
T_{11}	50% RDF only FYM @ 15 t ha^{-1} (50% N by FYM)	39.67	39.33	23.40	29.40	36.83	69.27	97.67	39.13
T_{12}	Local control	38.67	35.33	19.13	25.87	27.93	56.53	92.00	32.53
Sem (±)		1.66	1.78		1.94	1.73	2.62	5.32	8.93
CD (5%) =		NS	NS		5.70	5.07	7.68	15.61	26.19
CV (%) =		7.13	7.84		14.60	10.04	12.75	10.17	12.13

Table 2: Effect of growth parameters as influenced by nutrient sources of potato

Trt. No.	Treatment Details	Number of shoots per plant			Crop growth rate ($g/m^2/day$)			Fresh weight per plant (g)		
		30 DAS	50 DAS	70 DAS	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
T_1	125% RDF (187:125:125 kg ha^{-1} NPK)	5.53	5.80	3.90	1.76	2.99	2.73	59.67	189.33	138.67
T_2	100% RDF (150:100:100 kg ha^{-1} NPK)	4.20	3.73	3.53	1.02	2.85	1.69	44.00	151.33	133.33
T_3	75% RDF + FYM @ 7.5 t ha^{-1}(25% N by FYM)	3.80	3.27	3.00	1.54	2.39	2.18	31.00	125.00	122.00
T_4	50% RDF + FYM @ 15 t ha^{-1}(50% N by FYM)	3.27	3.27	3.27	1.36	2.90	2.32	26.33	156.67	108.67
T_5	75% RDF + Vermicompost @ 3.75 t ha^{-1} (25% N by Vermicompost)	4.13	3.73	3.33	1.95	2.20	2.65	35.33	150.00	101.33
T_6	50% RDF + Vermicompost @ 7.5 t ha^{-1} (50% N by Vermicompost)	5.83	6.03	4.37	1.77	3.17	2.71	61.67	211.67	145.67
T_7	Tuber treatment with Trichoderma @ 20 g /k + soil incorporation of Trichoderma enriched FYM @ 15 t ha^{-1} soil	4.67	3.73	3.17	0.79	2.72	1.57	32.00	134.33	106.00
T_8	Tuber treatment with Pseudomonas @ 20 g /k + soil incorporation of Pseudomonas enriched FYM @ 15 t ha^{-1} soil	4.93	4.27	3.00	1.21	2.07	2.17	44.33	113.33	97.00
T_9	Tuber treatment with Pseudomonas followed by Trichoderma @ 20 g /k + soil incorporation of consortia of Pseudomonas & Trichoderma enriched FYM @ 15 t ha^{-1} soil	3.73	3.33	3.73	1.40	2.80	2.30	28.33	128.33	113.00
T_{10}	Tuber treatment with consortia of Azotobacter & PSB @20 g /k + soil incorporation of consortia of Azotobacter & PSB enriched FYM @ 15 t ha^{-1} soil	5.43	6.00	3.83	1.64	2.85	3.13	46.67	160.00	137.00

T_{11}	50% RDF only FYM @ 15 t ha^{-1} (50% N by FYM)	4.60	3.47	3.47	1.26	2.84	1.84	31.67	115.00	118.00
T_{12}	Local control	3.30	3.00	2.77	0.89	2.22	1.54	27.00	96.00	91.00
Sem (±)			0.39	0.40	0.30	0.03	0.07	0.17	3.83	8.59
CD (5%) =			1.16	1.16	0.87	0.08	0.20	0.51	11.23	25.19
CV (%) =			15.41	16.55	14.96	3.62	4.40	13.52	17.00	10.31

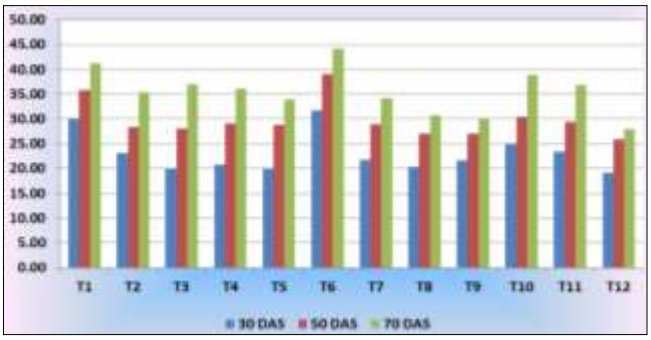

Fig 1: Effect of integrated nutrient management on Plant height (cm^2) - 30, 50 and 70 DAS

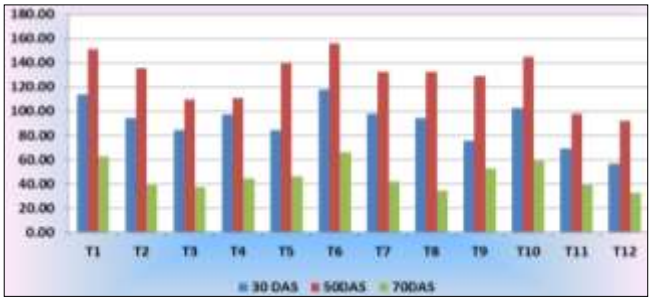

Fig 2: Effect of integrated nutrient management on Number of green leaves per plant - 30, 50 and 70 DAS

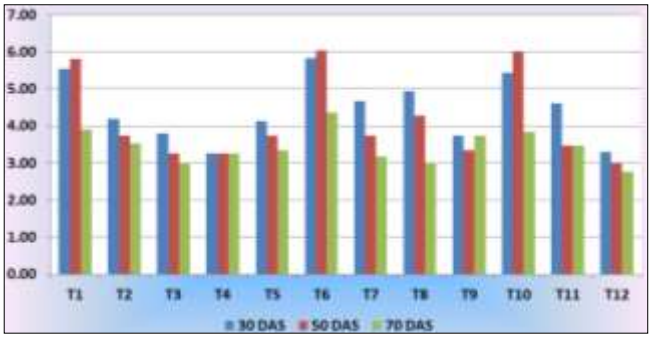

Fig 3: Effect of integrated nutrient management on Number of shoots per plant - 30, 50 and 70 DAS

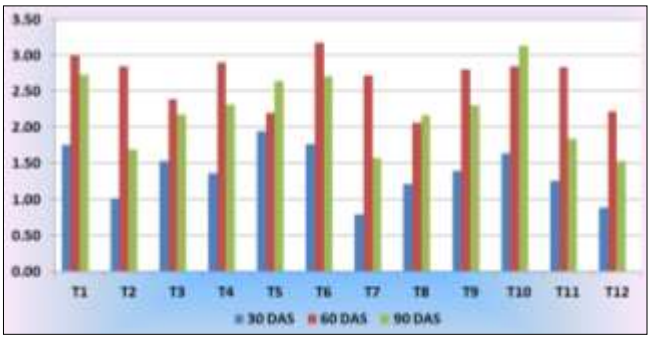

Fig 4: Effect of integrated nutrient management on Crop growth rate (CGR) at- 30, 60 and 90 DAS (g/m²/day)

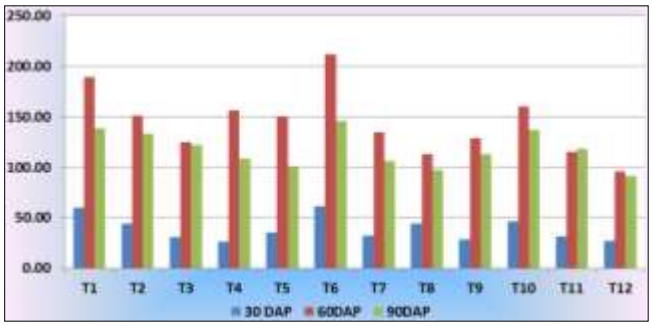

Fig 5: Effect of integrated nutrient management on Fresh weight per plant at- 30, 60 and 90 DAS

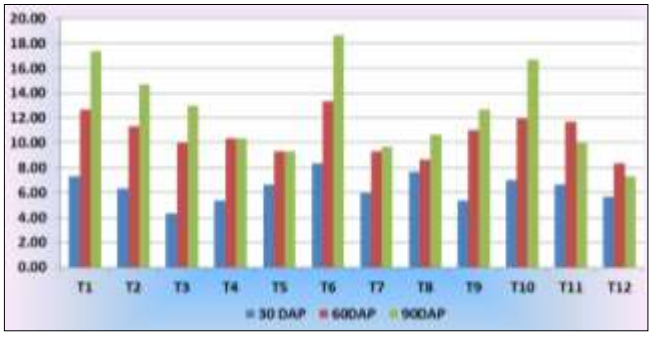

Fig 6: Effect of integrated nutrient management on Number of tuber late per plant at - 30, 60 and 90 DAS

Conclusion

The quantity of nutrients through organic sources were supplied in three forms viz., farmyard manure, vermicompost and biofertilizers at different levels on the basis of % nitrogen content. Inorganic major nutrients were supplied in the form of urea, single supper phosphate (SSP) and miurate of potash (MOP) to supply N, P and K, respectively. Among the different treatments, application of T6- (50% RDF + Vermicompost @ 7.5 t ha-1 (50% N by Vermicompost) had resulted in higher plant height (44.13 cm), number of green leaves and number of shoots per plant (66.40 and 4.37 respectively), and crop growth rate (2.17g/m2/day,) fresh tuber weight per plant (145.67 g), and number of tuber late per plant (18.67), 70 & 90 DAS and at harvest, respectively) was noticed in case of 50% RDF + Vermicompost @ 7.5 t ha-1 (50% N by Vermicompost)

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