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Evaluation of Potato (*Solanum tuberosum* L.) Growth Attributes under Natural Farming System in Gird Region of Madhya Pradesh, India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Aims: To evaluate growth attributes of potato under natural farming system in gird region of Madhya Pradesh.
Study Design: Randomized complete block design.
Place and Duration of Study: ICAR-Central Potato Research Institute- RS, research farm Gwalior during winter (*Rabi*) season of 2022-2023.

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Methodology: Selected 5 plants from each treatment and replicated 3 times. Then follows methods as per given in materials and methods section of paper. Treatments T_1: Control, T_2: Inorganic practices (standard technology), T_3: NADEP compost @ 25 t/ha + *Azotobacter* @ 1L/ha + PSB (Phosphorus solublizing bacteria) @ 1L/ha, T_4: T_3+ FYM @ 25 t/ha, T_5: T_3 + Vermicompost @ 7.5 t/ha, T_6: T_3+ neem cake @ 5 t/ha + foliar spray of copper oxychloride @ 3 g/L, T_7: Integrated practice [90% RDF through inorganic sources {urea, SSP, MOP}, 10% RDF through organic sources i.e., FYM @ 25 t/ha.

Results: Results revealed that treatment T_7 found better for growth parameters of potato *i.e.*, maximum plant emergence percentage (92.88%), maximum plant height (50.250 cm and 73.700 cm at 50 DAP and at harvest, respectively), highest number of stems (6.35 and 6.89 at 50 DAP and at harvest) per plant, Highest number of compound leaves (47.950 and 58.250 at 50 DAP and at harvest), Highest fresh haulm weight (0.245 kg and 0.382 kg at 50 DAP and at harvest), highest dry haulm weight (21.80 g and 25.20 g at 50 DAP and at harvest), tuber yield (48.78 kg/plot) and lowest values found in treatment T_1 – Control.

Conclusion: It is concluded that treatment T7 - Integrated practice [90% RDF through inorganic sources {urea, SSP, MOP}, 10% RDF through organic sources i.e., FYM @ 25 t/ha] found better than other treatments for growth parameters and yield of potato growing in grid region of Madhya Pradesh.

Keywords: FYM; growth; organic; potato; RDF.

1. INTRODUCTION

Potato (*Solanum tuberosum* L.) is very crucial food crop in the world. It is also referred to as economical food as it provides much nutrition in low cost. Potatoes are rich in starch, amino acids (tryptophane and isoleucine) vitamins (C, B_1) and minerals [1]. It also contains carbohydrates (20.6%), protein (0.3%) and ash (0.9%), crude fiber (1.1%) [2]. It is mostly used for vegetable purpose but has certain industrial value and it can also be used for making chips, French fries and many packaged items.

Among vegetable crops, potatoes take up the most land. It requires a maximum temperature of less than 35^0C and below 20^0C as minimum temperature. It requires a temperature ranging from 16 to 22^0C and slightly acidic conditions for tuberization. India accounts for 7.58% of potato production in the world FAO STAT, [3] and ranks 2nd in its area and production after China. Uttar Pradesh is the leading potato producer in India. Potato is grown on 2.05 million hectares in India, with a production of 48.66 million tones and an average yield of 23670 kg/ha [4]. Madhya Pradesh comprises 7.36 and 7.43% of the country's potato area and production, respectively.

The role of soil organic carbon in maintaining the soil fertility is well known to everyone from the past times. The maintenance of soil health is the fore most concern in present time when we are concerned about increasing the productivity per unit area. We all know that by the intensive use of chemical fertilizers the quality of the soil is degrading day by day. Due to the health issues too, we need to shift from the inorganic to organic crop production to maintain the soil health and productivity.

Among the organic sources, FYM is a well-known source which releases nutrient into the soil after the proper decomposition by the microorganisms. Its long-term addition results in improved biological activity [5,6]. Vermi-compost also adds organic matter and makes the soil fertile. Organic matter in soil acts as a storehouse of nutrients [7]. Neem cake along with the supply of nutrients also provides protection against insect pest [8].

Biofertilizers like *Azotobacter* & PSB have also been found beneficial to improve nutrient status in soil like nitrogen and phosphorus. PSB secrets organic acids which lowers the soil pH bringing about the dissolution of bound form of phosphorus [9].

2. MATERIALS AND METHODS

2.1 Experimental Site

The experiment was carried out in the ICAR-Central Potato Research Institute-RS, research

farm in Gwalior which is located at 26°13' North latitude, 78°14' East longitude and 206 meters above mean sea level in the North tract of M.P.

2.2 Climatic Conditions

Gwalior's climate is subtropical, with summer temperatures reaching up to 48° C and minimum temperature as low as 4.0°C during the winter season. The annual rainfall ranges between 750 and 800 mm, with the majority falling between the end of June and end of September, with only a few showers in the winter months. Mean monthly meteorological data (maximum and minimum temperature, relative humidity, evaporation and precipitation) were collected at the Meteorological Observatory-College of Agriculture, Gwalior during the crop growth season. According to the data the total rainfall received during the crop growth period was 17.4 mm. during the crop growing period the average maximum and lowest temperature were 28°c and 10°c, respectively. The relative humidity ranged from 37.2% to73.4%.

2.3 Treatment Details

T_1: Control, T_2: Inorganic practices (RDF), T_3: NADEP compost @ 25 t/ha + *Azotobacter* @ 1L/ha + PSB @ 1L/ha, T_4: T_3+ FYM @ 25 t/ha, T_5: T_3+Vermicompost @ 7.5 t/ha, T_6: T_3+ neem cake @ 5 t/ha + foliar spray of copper oxychloride @ 3 g/L (for management of foliar diseases), T_7: Integrated practice [90% RDF through inorganic sources {urea, SSP, MOP}, 10% RDF through organic sources i.e., FYM @ 25 t/ha.

2.4 Observations Taken

2.4.1 Plant emergence (%)

This observation was made with the goal of determining the influence of various treatments on emergence. Plant emergence was recorded at 30 days after planting, when the emergence was complete.

2.4.2 Plant height (cm) per plant

At 50 days after planting and at harvest, the height of the main stem from the ground level to the apical bud (leaf apex) was measured with a meter scale.

2.4.3 Number of shoots (stems) per plant

At 50 days after planting and at harvest, the number of shoots sprouting from the main stem of each tagged plant was counted.

2.4.4 Number of compound leaves per plant

At 50 DAP and harvest, the number of compound leaves on each tagged plant in all treatments was counted.

2.4.5 Fresh haulm weight (g) per plant

The plant's fresh haulm weight (g) was recorded using an electronic weighing scale at 50 DAP and at harvest.

2.4.6 Dry haulm weight (g) per plant

The plant's dry haulm weight was determined by dehydrating the plants first by sun drying and then oven drying, and then calculating the weight using an automated weighing scale at 50 DAP and harvest.

2.5 Data Analysis

The data based on the mean of individual plants selected for observation were statistically analyzed described by Panse and Sukhatme [10] to find out overall total variability present in the material under study for each character and for all the populations.

3. RESULTS AND DISCUSSION

3.1 Growth Parameters

3.1.1 Plant emergence (%)

According to the data recorded, the treatments were not affected significantly. The reason is obvious that well sprouted healthy seed tubers were planted which provided favorable condition for emergence and also initial growth of potato depends on storage of food material inside the tubers [11].

3.1.2 Plant height (cm)

The maximum plant height (50.25 cm and 73.70 cm at 50 DAP and at harvest, respectively) was obtained with T_7 which was significantly higher

over other treatments. The minimum plant height (35.25 cm, and 47.45 cm at 50 DAP and at harvest respectively) was obtained with T_1. This may be attributed to the combined presence of essential nutrients. In the initial growth phases, fertilizers facilitated growth by supplying the necessary nutrients, resulting in a steady increase in plant height. Barman *et al*. [11] recorded maximum plant height under treatment T_5 (Vermicompost @ 2.5 t/ha + half NPK through inorganic fertilizer). Mohammed *et al*. [12] recorded highest plant height in treatment (10 t FYM ha^{-1} + 111 kg N ha^{-1} + 92 kg P_2O_5 ha^{-1}). Dev *et al*. [13] were found significant result due to application of RDF 75%+ 25% FYMN along with the successive increment doses of ZnSO4. Choudhary and Rawat [14] found that highest plant height was recorded in treatment T_4 (75% RDF of NPK + FYM (Farm Yard Manure) @ 50 t/ha + PSB @ 10 kg/ha). Kumar *et al*. [15] found that the maximum plant height was recorded with treatments T_6 (TGG @ 5 t ha^{-1} along with 75% RDF), which was remained at par to all the integrated nutrient management treatments. Pandey *et al*., [16] also reported that plant growth parameters (plant height) remains unaffected up to 50% replacement of inorganic by organics sources but yield decreased significantly.

3.1.3 Number of stems per plant

Highest number of stems (6.35 and 6.89 at 50 DAP and at harvest) per plant have been reported in T_7. Numbers of stems per haulm depends on the nutrition available in the soil. The availability of nitrogen, phosphorus and potassium with sufficient quantity, therefore, seems the main cause of increased number stems per haulm. The positive and significant effect on nitrogen, phosphorus and potash on number of stems per haulm also reported by Barman *et al*. [11]. Mohammed *et al*. [13] found that application of both organic and inorganic fertilizers had no any effect on the number of main stem of potato. Islam *et al*., [17] found that higher no. of stem/plant found in treatment – Poultry Manure @ 3 t ha^{-1} + rest nutrients from RDF.

3.1.4 Number of compound leaves per plant

Highest number of compound leaves (47.95 and 58.25 at 50 DAP and at harvest) were recorded in treatment T_7. This is might be due to the integrated use of organic manures, inorganic fertilizers that enhanced the plant's nitrogen utilization ability [18]. Choudhary and Rawat [14] found that maximum number of compound leaves was recorded in treatment T_4 (75% RDF of NPK + FYM (Farm Yard Manure) @ 50 t/ha + PSB @ 10 kg/ha).

3.1.5 Fresh haulm weight (kg) per plant

Highest fresh haulm weight (0.245 kg and 0.382 kg at 50 DAP and at harvest) were recorded in treatment T_7. This is due to more and continuous availability of nutrients, therefore, more cell division and cell enlargement, hence a greater fresh haulm weight per plant [19]. Mohammed *et al*. [12] revealed that the use of farmyard manure and N was significantly influence the above ground biomass of the crop, but P_2O_5 fertilizers did not affect this parameter of the plant. Kumar *et al*. [15] found that highest haulms production was obtained with the application of FYM 25 t ha-1 + 100% RDF.

Design	**:**	**Randomized Block Design**
Treatment	:	7
Replication	:	4
Total number of plots	:	28
Net plot size	:	3.6 m x 3.6 m
Number of plants for observation per plot	:	5
Plot to plot distance	:	1.2 m
Distance between replication	:	1.2 m
Crop	:	Potato (*Solanum tuberosum* L.)
Variety		Kurfi Mohan
Season	:	2022-23
Date of planting	:	16–11–2022
Fertilizers (RDF)	:	N, P_2O_5, K_2O 180:80:120kg ha^{-1}, respectively

Table 1. Effect of treatments on plant emergence, plant height, number of stems per plant, fresh haulm weight and dry haulm weight

Treatments	Plant emergence (%)	Plant height		Number of stems per plant		Number of compound leaves per plant		Fresh haulm weight (kg)		Dry haulm weight (g)		Yield (kg/plot)
		50 DAP (cm)	at Harvest (cm)	at 50 DAP	at Harvest	at 50 DAP	at Harvest	at 50 DAP	at Harvest	at 50 DAP	at Harvest	
T1	92.65	35.20	47.40	3.83	4.55	36.55	43.86	0.11	0.153	16.54	18.77	32.11 kg
T2	92.80	45.00	61.60	5.55	6.25	46.85	53.90	0.228	0.206	21.51	25.197	46.86 kg
T3	91.04	39.20	48.90	4.65	5.43	44.73	48.75	0.137	0.197	18.86	21.37	38.16 kg
T4	91.70	41.00	60.90	4.25	5.60	45.25	55.35	0.149	0.176	18.76	20.99	39.00 kg
T5	91.89	41.50	55.40	4.96	6.30	42.25	45.70	0.169	0.174	21.48	23.36	38.27 kg
T6	91.73	42.50	59.00	4.05	6.28	41.27	55.20	0.198	0.183	19.53	22.28	41.35 kg
T7	92.88	50.20	73.70	6.35	6.88	47.95	58.25	0.245	0.382	21.80	25.20	48.78 kg
S.Em ±	0.98	1.90	3.90	0.41	0.25	2.27	2.75	0.023	0.015	0.937	0.275	0.545
CD at 5%	N.S	5.80	11.90	1.22	0.77	6.82	8.25	0.692	0.047	2.804	0.821	1.614

3.1.6 Dry haulm weight (g) per plant

Highest dry haulm weight (21.80 g and 25.20 g at 50 DAP and at harvest) were recorded in treatment T_7 and T_2 respectively. This is obviously due to higher fresh haulm weight. Millard and Marshall [20] reported a significant increment in canopy dry matter yield of potato in response to increased nitrogen application. Singh *et al*. [19] revealed that the maximum fresh weight was recorded with application of 75% RDF + 2 tonnes ha^{-1} FYM + 20 kg ha^{-1} Sulphur + 20 kg ha^{-1} Zinc sulphate + 1 tonnes ha^{-1} Vermicompost + Azotobacter (seed treatment).

3.1.7 Tuber yield (kg/plot)

Highest tuber yield (48.78 kg/plot) recorded in treatment T_7 and minimum yield recorded in control treatment (32.11 kg/plot). This might be due to application of fertilizers in combination with organic manure which increased the nutrient-use efficiency through modification of soil physical condition, and resulted in higher total uptake of nutrients because of better root penetration leading to better absorption of nutrients and moisture. Raghav *et al*., [18] reported maximum tuber yield of potato under the treatment receiving combinations of organic manures (FYM, poultry manure, vermicompost). Singh *et al*., [19] revealed that the highest tuber yield was recorded with application of 75% RDF + 2 tonnes ha^{-1} FYM + 20 kg ha^{-1} Sulphur + 20 kg ha^{-1} Zinc sulphate + 1 tonnes ha^{-1} Vermicompost + Azotobacter (seed treatment). Hensh *et al*., (2020) found that Maximum tuber yield of potato was recorded with treatment T_{10}-80% RDN through chemical fertilizer + 20% through vermicompost + biofertilizer). According to Chudhary and Rawat [14] highest tuber yield was recorded in treatment T_4 (75% RDF of NPK + FYM @ 50 t/ha + PSB @ 10 kg/ha). Das *et al*., [21] reported that the integrated nutrient management by application of both inorganic fertilizers and organic manures increase the different grades tuber production.

4. CONCLUSION

It is concluded that treatment T_7 - Integrated practice [90% RDF through inorganic sources {urea, SSP, MOP}, 10% RDF through organic sources i.e., FYM @ 25 t/ha] found better than other treatments for growth parameters and yield of potato growing in grid region of Madhya Pradesh.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Visvanathan R, Jayathilake C, Jayawardana B, Liyanage R. Health-beneficial properties of potato and compounds of interest. J. Sci. Food Agric. 2016:96:4850-4860. DOI:10.1002/jsfa.7848
2. Zhang YL, Wang FX, Shock, CC, Yang, KJ, Kang, SZ, Qin, JT, Li, SEn. Effects of plastic mulch on the radiative and thermal conditions and potato growth under drip irrigation in arid Northwest China. Soil & Tillage Research. 2017:172:1-11.
3. FAO STAT. Food and agriculture organisation statistics database on the World Wide Web. 2018.
4. Anonymous. Agricultural Statistics at a Glance, Government of India. 2021:0-388.
5. Collins HP, Rasmussen PE, Douglas CL. Crop rotation and residue management effects on soil carbon and microbial dynamics. Soil Science Society of America Journal. 1992:56:783-788.
6. Fauci MF, Dick RP. Microbial Biomass as an Indicator of Soil Quality: Effects of Long-Term Management and Recent Soil Amendments in Defining Soil Quality for a Sustainable Environment, SSSA Special Publications. 1994:35.
7. Jack AL, Thies JE. Compost and vermicompost as amendments promoting soil health. Biological Approaches to Sustainable Soil Systems, ed N. Uphoff (New York, NY: CRC Press), 2006:453-466.
8. Sinha R, Singh B, Rai PK, Kumar A, Jamwal S, Sinha BK. Soil fertility management and its impact on mustard aphid, Lipaphis erysimi (Kaltenbach) (Hemiptera: Aphididae). Cogent Food & Agriculture. 2017:4(1). Available:https://doi.org/10.1080/23311932.2018.1450941
9. Sahoo RK, Bhardwaj D, Tuteja N. Biofertilizers: A Sustainable Eco-Friendly

Agricultural Approach to Crop Improvement. In: Tuteja N, Singh Gill S. (eds) Plant Acclimation to Environmental Stress. Springer, New York, NY; 2013. Available:https://doi.org/10.1007/978-1-4614-5001-6_15

10. Panse VC, Sukhatme PV. Statistical methods for agricultural workers. ICAR Publications, New Delhi. 1985;155.
11. Barman KS, Kumar A, Kasera S, Ram B. Integrated nutrient management in potato (*Solanum tuberosum*) cv. Kufri Ashoka. Journal of Pharmacognosy and Phytochemistry. 2018:SP1:1936-1938.
12. Mohammed A, Mohammed M, Dechasa N, Abduselam F. Effects of Integrated Nutrient Management on Potato (*Solanum tuberosum* L.) Growth, Yield and Yield Components at Haramaya Watershed, Eastern Ethiopia. Open Access Library Journal. 2018:5:e3974.
13. Dev A, Kumar S, Kumar D, Patel VK, Kumar A, Sahu RK, Singh P. The Effect of Integrated Nutrient Management (INM) and Zn Fertilization on Yield of Potato. Int.J.Curr.Microbiol.App.Sci.2020:9(04):1518-1526.
14. Chaudhary A, Rawat M. Response of Potato (*Solanum tuberosum* L.) to Integrated Nutrient Management in Sandy Loam Soils of Punjab. Biological Forum – An International Journal. 2022:4(1):1235-1240.
15. Kumar P, Kumar A, Kumar N, Ahamad A, Verma MK. Effect of Integrated Nutrient Management on Productivity and Nutrients Availability of Potato. Int.J.Curr.Microbiol.App.Sci.2017:6(3):1429-1436.
16. Pandey SK, Sarkar KC. Nutrient management in potato based Cropping System. Indian Journal of fertilizer. 2008: 3(9):91-98&101-107.
17. Islam MM, Akhter S, Majid NM, Ferdous J, Alam MS. Integrated nutrient management for potato (Solanum tuberosum) in grey terrace soil (*Aric Albaquipt*). Australian Journal of Crop Science. 2013:7(9):1235-1241.
18. Raghav M, Kumar T, Kamal S. Effect of organic sources on growth, yield and quality of potato. Annals of Horticulture. 2008:1(1):67-70.
19. Singh G, Kumar A, Singh G, Kaur M, Jatana MS, Rani S. Effect of Integrated Nutrient Management on Growth and Yield Attributes of Potato (*Solanum tuberosum* L.). International Journal of Current Microbiology and Applied Sciences. 2018: 7(6):2051-2056.
20. Millard P, Marshall B. Growth, Nitrogen Uptake and Partitioning within the Potato crop (*Solanum tuberosum* L.) in Relation to Nitrogen Application. The Journal of Agricultural Science. 1986:107:421-429. Available:https://doi.org/10.1017/S0021859600087220
21. Das PP, Sarkar A, Zamen A. Response of organic and inorganic sources of nutrients on growth and yield of potato in Gangetic alluvial plains of West Bengal. In Proceedings of 96th Indian Science Congress, part-II (Abstract), 3-7th Jan. at NEHU, Shillong, Meghalaya; 2009.

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