

Influence of Different Levels Organic and Inorganic Fertilizer Growth and Yield of Potato (*Solanum tuberosum* L.)

Abstract

The global food demand of growing human population and need for eco-friendly strategy for sustainable soil-plant-microbes-environmental system currently a crucial challenge. In conventional farming for increasing the crop yield farmers are using huge amount of chemical fertilizer in the fields. Due to either over or imbalance use of chemical fertilizers in cultivation of crops, degraded the soil fertility and health of soil. Such farming is blamed for land degradation and environment pollution and adversely affecting the human health, plants and animals. Soil degradation contributes to low agricultural productivity. Organic amendments (OAs) have the potentials to reverse soil degradation processes by improving the soil's physical and chemical properties and consequently improve crop growth and yield performance. An experiment was carried out during the winter season of 2021- 2022 to know the Effect of different levels of Vermicompost, Neem cake and fertilizer on soil health and yield of Potato (*Solanum tuberosum* L.)". The experiment was laid out in Randomised Block Design (RBD) with three replicates for each treatment. The fertilizer applied for the crop was NPK and @ 120kg, ha⁻¹, 80kg ha⁻¹, 120kg ha⁻¹, Vermicompost 6 and Neem cake 3 t ha⁻¹, respectively, showed significant influence on the soil health of Potato. Based on the above research work, it is concluded that application of Vermicompost, Neem cake and fertilizer, treatment T9@[NPK 100% + VC @100% + Neem Cake @ 100% ha⁻¹] was found more beneficial and significantly improved soil, and tuber yield of Potato grown under Allahabad Agro-climatic conditions.

Keywords: Soil properties, nitrogen, phosphorus, potassium, soil health, yield and potato.

INTRODUCTION

Potato (*Solanum tuberosum*, L.) is considered as one of the most important vegetable food crops all over the world, As a world crop, it ranks the first most important tuber crop, and next to wheat and rice (Alam *et al.* 2007). Potato tubers are an important source of digestible carbohydrates, dietary fiber, vitamin C, and some necessary minerals (Sarhan *et al.* 2004). So, it can use as a staple food, vegetable, source of starch,

flour, alcohol, acetone and glucose. Nitrogen (N), Phosphorus (P) and potassium (k) are considered as the most three important elements prerequisite for plant nutrition in large amounts. They play essential roles in overall metabolism of plant enzymes activity, promoting photosynthesis, cell division and development of meristematic tissue, nitrogen and water consumption respiration. Since, nitrogen (N) is an essential element for building up protoplasm, proteins and amino acids, which induce cell division and initiate meristematic activity. Also, phosphorus is a part of molecular structure of nucleic acid (DNA and RNP), the energy transfer compounds and phosphor-proteins. Moreover, potassium element is very important in overall metabolism of plant enzymes activity. It is important to serve a vital role in photosynthesis by direct increasing in growth and leaf area and hence CO₂ assimilation (Gardener *et al.* 1985). The effects of the three mineral fertilizers nitrogen (N), phosphorus (P) and potassium (K) individually or in combination with either one or more of each potato cultivar plants were reported by several investigations such as: Brijlal and Sharma (1995) using K; Danilchenko *et al.* (2005) and Alam *et al.* (2007) using NPK. Since, they found that using such fertilizers reflected significant effects on the vegetative, yield and chemical compositions characters of potato plants.

It is well known that organic manure improved the structure of the soil and this consequently encourage the plant to have a good growth. Moreover, the slow released nutrients contained in organic manure permit the plants to be beneficial of it. Organic manures maintain and increase the long-term fertility of soil. They avoid all forms of pollution. Organic manures maintain the genetic diversity of potato and also allow adequate returns and satisfaction to potato growers from their work including a safe working environment. Organic manures act not only as a source of nutrients and organic matter, but also increase microbial diversity and activity in soil, which influence soil structure and nutrients rotation, in addition to improvement in other physical, chemical and biological properties of the soil. All these reasons resulted in improved plant growth. Studies were also made by several researchers on the effects of organic and inorganic fertilizers on vegetative growth, yield, and chemical compositions of potato, such as; Spoil and Fedotova (1987); Das and Banerjee (1996); Eiecharczyk and Malecka (2000); Danilchenko *et al.* (2005) and Singh and Kushwah (2006).

Vermicompost has been found to effectively enhance the root formation, elongation of stem and production of biomass in potato crop. Using of vermicompost is now a global

movement for the second green revolution that emphasizes on composting. Ghosh et al., (1999) observed that integration of vermicompost with inorganic fertilizers tends to increase the yield of potato crop. Vermicompost has higher level of nitrogen (1.6%), phosphorous (0.7%) and potassium (0.8%), calcium (0.2%) (Buchanan et al., 1988). The use of vermicompost as long been considered as effective means of improving the structure and fertility of soil (Haj et al., 2011). Neem cake organic manure is the by-product obtained in the process of cold pressing of neem fruits and kernels, and the solvent extraction process for neem oil cake. Neem cake organic manure is used directly and/or in blends with urea or with other organic manure like seaweed or farmyard manure to an extent of 15-20% by weight, for higher yields in various crops. Neem Cake Organic Manure has more nitrogen, phosphorous, potassium, calcium and magnesium than the farmyard manures. It is rich in sulphur compounds as well as bitter limonoids content of neem cake N-1.5%, P 1.0%, K 1.4%, Ca 0.96% and Na 0.4%. Therefore, the main objective of this study was to investigate the effects of organic manure and inorganic NPK in soil health and yield of potato plants.

MATERIALS AND METHODS

Two field experiments were carried out during the two consecutive winter seasons of 2020-21 and 2021-22 Research Farm of Soil Science and Agricultural Chemistry, Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad University of Agriculture, Technology and Sciences (U.P.) located at 25° 57' N latitude 81° 57' E longitude and 98m above mean sea level. Agro climatically, Allahabad district represents the subtropical belt of the South East of Uttar Pradesh, and is endowed with extremely hot summer and fairly cold winter. The maximum temperature of the location ranges between 46 °C - 48 °C and seldom falls below 4 °C - 5 °C. The relative humidity ranges between 20-94%. The average rainfall of this area is around 1100mm annually. The treatment combination was laid out as T₁- (Control)-NPK 0% Recommended Dose of Fertilizer (RDF) + vermicompost @ 0t ha⁻¹ + Neem cake @ 0t ha⁻¹, T₂- NPK 0% RDF + Vermicompost @ 3t ha⁻¹ + Neem cake @ 0.6t ha⁻¹, T₃-NPK 0% RDF + vermicompost @ 6t ha⁻¹ + Neem cake @ 1.2t ha⁻¹, T₄-NPK 50% RDF + Vermicompost @ 0t ha⁻¹ + Neem cake @ 0t ha⁻¹, T₅-NPK 50% + Vermicompost @ 3t ha⁻¹ + Neem cake @ 0.6 t ha⁻¹, T₆- NPK 50% RDF + Vermicompost @ 6t ha⁻¹ + Neem cake @ 1.2t ha⁻¹, T₇-NPK 100% RDF + Vermicompost @ 0t ha⁻¹ + Neem cake @ 0t ha⁻¹, T₈-NPK 100% RDF + Vermicompost @ 3t ha⁻¹ + Neem cake @ 0.6t ha⁻¹, T₉-NPK 100% RDF +

Vermicompost @ 6t ha⁻¹ + Neem cake @ 1.2t ha⁻¹, respectively .

RESULTS AND DISCUSSIONS

Plant height (cm)

The data pertaining in table 1 reveals that the effect of different level of vermicompost, Neem cake and fertilizers on plant height at 30, 60 and 90 DAS were significantly differ among the treatment in both the years. At 30 DAS, the maximum plant height was observed in T9 (26.28cm and 27.75 cm) followed by T8 (25.67 and 27.20) while minimum plant height was recorded in T1 (17.45 and 17.82) in the both years. At 60 DAS, maximum plant height was observed in T9 (37.23 cm and 41.16 cm) followed by T8 (34.63 and 39.23) T7 (33.19 and 36.63) while minimum plant height was recorded in T1 (22.73 and 24.83) in the both years. At 90 DAS, maximum plant height was observed in T9 (43.97 and 48.63 cm) followed by T8 (43.21 and 46.21), while minimum plant height was recorded in T1 (28.47) in the both years. Pooled data of two years, plant height were significantly increased over the control in three DAS (30,60 and 90 DAS) and maximum plant height was observed in T9 (27.02,39.20 and 46.30 cm) followed by T8 (26.44,36.93 and 44.71) while minimum plant height was recorded in T1 (17.64, 23.78 and 28.47) respectively. Appropriate fertilization was reported to increase the average fresh tuber, plant height, leaf number and tuber; weight per plant responded positively application and Leaf area increased (Kandil *et al.*, 2011). Similar finding were also observed by Habibi and Thomas (2016), Gulam and David (2019), Lanunpiuia *et al.*, (2019), Taha.*et al* (2019) and Dey *et al.*, (2015).

Table 1: Influence of Vermicompost, Neem cake and Inorganic Fertilizers on Plant Height (cm) of Potato

Treatments	(2020-21)			(2021-22)			Pooled		
	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
T ₁	17.45	22.73	28.47	17.82	24.83	28.47	17.64	23.78	28.47
T ₂	17.78	24.83	30.03	18.89	25.45	30.03	18.34	25.14	30.03
T ₃	19.18	25.45	32.64	19.03	27.56	32.64	19.11	26.51	32.64
T ₄	20.6	27.56	34.97	20.93	29.13	34.97	20.77	28.35	34.97
T ₅	22.89	31.13	37.22	25.36	34.13	40.22	24.13	32.63	38.72
T ₆	24.31	32.13	39.33	26.12	35.19	42.33	25.22	33.66	40.83
T ₇	24.92	33.19	40.79	26.52	36.63	43.79	25.72	34.91	42.29

T₈	25.67	34.63	43.21	27.2	39.23	46.21	26.44	36.93	44.71
T₉	26.28	37.23	43.97	27.75	41.16	48.63	27.02	39.20	46.30
F – test	S	S	S	S	S	S	S	S	S
CD @ 5%	0.65	1.59	2.22	1.15	1.74	2.25	0.90	1.67	2.24
S. Ed. (±)	0.3	0.75	1.04	0.53	0.82	1.06	0.42	0.79	1.05

Number of leaves plant⁻¹

The data pertaining in table 2 reveals that the effect of different level of vermicompost, Neem cake and fertilizers on Leaves plant⁻¹ at 30,60 and 90 DAS were significantly differ among the treatment in both the years.. At 30 DAS the maximum plant height was observed in T₉ (15.20 cm and 17.10 cm) followed by T₈ (14.67 and 16.57) while minimum Leaves plant⁻¹ was recorded in T₁ (9.33 and 10.50) in the both years. At 60 DAS maximum Leaves plant⁻¹ was observed in T₉ (23.53 cm and 28.03 cm) followed by T₈ (22.53 and 27.03) T₇ (21.47 and 25.97) while minimum Leaves plant⁻¹ was recorded in T₁ (15.27 and 19.77) in the both years. At 90 DAS, maximum Leaves plant⁻¹ was observed in T₉ (37.86 and 42.36 cm) followed by T₈ (33.65 and 38.15), while minimum Leaves plant⁻¹ was recorded in T₁ (19.91 and 24.74) in the both years. Pooled data of two years, leaves plant⁻¹ were significantly increased over the control in three DAS(30,60 and 90 DAS) and maximum leaves plant⁻¹ was observed in T₉ (16.15,25.78 and 40.11 cm) followed by T₈ (15.62,24.78 and 35.90 cm) while minimum Leaves plant⁻¹ was recorded in T₁ (9.92,17.52 and 22.33) respectively in the both years. Appropriate fertilization was reported to increase the average fresh tuber, plant height, leaf number and tuber; weight per plant responded positively application and Leaf area increased (Kandil *et al.*, 2011). Similar finding were also observed by Habibi and Thomas (2016), Gulam and David (2019), Lanunpiuia *et al.*, (2019), Taha *et al.*, (2019) and Dey *et al.*, (2015).

Table 2: Influence of Vermicompost Neem cake and Inorganic Fertilizers on Number Leaves Plant⁻¹ of Potato

Treatments	(2020-21)			(2021-22)			Pooled		
	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS
T ₁	9.33	15.27	19.91	10.50	19.77	24.74	9.92	17.52	22.33

T₂	9.67	15.6	22.55	11.13	20.10	27.05	10.40	17.85	24.80
T₃	10.67	16.07	22.79	13.43	21.13	27.29	12.05	18.60	25.04
T₄	13.13	18.87	26.21	15.53	23.37	30.71	14.33	21.12	28.46
T₅	14.6	20.2	27.29	16.9	24.7	31.79	15.75	22.45	29.54
T₆	14.2	19.53	30.43	17.43	24.77	34.93	15.82	22.15	32.68
T₇	14.40	21.47	31.08	16.3	25.97	35.58	15.35	23.72	33.33
T₈	14.67	22.53	33.65	16.57	27.03	38.15	15.62	24.78	35.90
T₉	15.20	23.53	37.86	17.1	28.03	42.36	16.15	25.78	40.11
F - test	S	S	S	S	S	S	S	S	S
CD @ 5%	1.02	1.72	3.34	1.13	1.75	3.35	1.08	1.74	3.35
S.Ed. (±)	0.48	0.81	1.57	0.53	0.82	1.56	0.51	0.82	1.57

Number of Tubers Plant⁻¹

Number of Tubers Plant⁻¹ presented in table 3 reveals that effect of different level of vermicompost, neem cake and fertilizers when subjected to statistical analysis indicated that there was a significantly difference among the treatments during the both year. Comparatively maximum Number of Tubers Plant⁻¹ was observed in treatment T₉ (8.81 and 9.14) followed by T₈ (8.23 and 8.37) while minimum Number of Tubers Plant⁻¹ was recorded in T₁ (6.57 and 6.91) in the both years. Pooled data of two years shows that Number of Tubers Plant⁻¹ significantly increased over the control and maximum Number of Tubers Plant⁻¹ was observed in T₉ (8.98) followed by T₈ (8.43) while minimum Number of Tubers Plant⁻¹ was recorded in T₁ (6.74) respectively in the both years. Appropriate fertilization was reported to increase the average fresh tuber, plant height, leaf number and tuber; weight per plant responded positively application and Leaf area increased (Kandil *et al.*, 2011). Similar finding was also observed by Habibi and Thomas (2016), Gulam and David (2019), Lanunpiuia *et al.*, (2019), Taha *et al* (2019) and Dey *et al.*, (2015).

Table 3: Influence of Vermicompost Neem cake and Inorganic Fertilizers on Number of Tubers Plant⁻¹ of Potato

Treatments	(2020-21)	(2021-22)	Pooled
T₁	6.57	6.91	6.74
T₂	6.81	7.14	6.98
T₃	7.06	7.33	7.20

T₄	7.22	7.49	7.36
T₅	7.31	7.7	7.51
T₆	7.89	8.09	7.99
T₇	8.03	8.37	8.20
T₈	8.23	8.63	8.43
T₉	8.81	9.14	8.98
F – test	S	S	S
CD @ 5%	0.82	0.46	0.64
S. Ed. (±)	0.38	0.22	0.30

Tuber Yield (t ha⁻¹)

Tuber Yield (t ha⁻¹) of Potato presented in table 4 reveals that effect of different level of vermicompost, neem cake and fertilizers when subjected to statistical analysis indicated that there was a significantly difference among the treatments during the both years. Comparatively maximum Tuber Yield (t ha⁻¹) was observed in treatment T₉ (32.13 and 34.24) followed by T₈ (21.62 and 23.88) while minimum Tuber Yield (t ha⁻¹) was recorded in T₁ (7.88 and 8.07) in the both year. Pooled data of two years shows that Tuber Yield (t ha⁻¹) significantly increased over the control and maximum Tuber Yield (t ha⁻¹) was observed in T₉ (33.19) followed by T₈ (22.75) while minimum Tuber Yield (t ha⁻¹) was recorded in T₁ (7.98) respectively in the both years. Appropriate fertilization was reported to increase the average fresh tuber, plant height, leaf number and tuber; weight per plant responded positively application and Leaf area increased (Kandil *et al.*, 2011). Similar finding were also observed by Habibi and Thomas, (2016), Gulam and David (2019), Lanunpiuia *et al.*, (2019), Taha.*et al.*,(2019) and Dey *et al.*, (2015).

Table 4: Influence of Vermicompost Neem cake and Inorganic Fertilizers on Tuber Yield (t ha⁻¹) of Potato

Treatments	(2020-21)	(2021-22)	Pooled
T₁	7.88	8.07	7.98
T₂	12.68	12.73	12.71
T₃	21.09	22.31	21.70
T₄	12.68	13.02	12.85
T₅	19.17	20.4	19.79
T₆	26.37	27.73	27.05

T₇	15.82	17.56	16.69
T₈	21.62	23.88	22.75
T₉	32.13	34.24	33.19
F – test	S	S	S
CD @ 5%	4.53	5.55	5.04
S.Ed. (±)	2.07	2.64	2.36

Haulm Yield (t ha⁻¹)

Haulm Yield (t ha⁻¹) of Potato presented in table 5 reveals that effect of different level of vermicompost, neem cake and fertilizers when subjected to statistical analysis indicated that there was a significantly difference among the treatments during the both years. Comparatively maximum Haulm Yield (t ha⁻¹) was observed in treatment T₉ (3.23 and 3.3) followed by T₈ (2.99 and 3.05) while minimum Number of Tubers Plant⁻¹ was recorded in T₁ (1.56 and 1.63) in the both year. Pooled data of two were on haulm yield (t ha⁻¹) showed significant in both the years and maximum haulm yield (t ha⁻¹) was observed in T₉(3.27) followed by T₈ (3.02) while minimum Haulm Yield (t ha⁻¹) was recorded in T₁ (1.60) respectively in the both years. Appropriate fertilization was reported to increase the average fresh tuber, plant height, leaf number and tuber; weight per plant responded positively application and Leaf area increased (Kandil *et al.*, 2011). Similar finding were also observed by Habibi and Thomas, (2016), Gulam and David, (2019), Lanunpiuia *et al.*, (2019), Taha.*et al.* ,(2019) and Dey *et al.*, (2015).

Table 5 : Influence of Vermicompost Neem cake and Inorganic Fertilizers on Haulm Yield (t ha⁻¹) of Potato

Treatments	(2020-21)	(2021-22)	Pooled
T₁	1.56	1.63	1.60
T₂	1.75	1.82	1.79
T₃	2.03	2.1	2.07
T₄	2.33	2.4	2.37
T₅	2.56	2.63	2.60
T₆	2.44	2.5	2.47
T₇	2.61	2.67	2.64
T₈	2.99	3.05	3.02
T₉	3.23	3.3	3.27

F – test	S	S	S
CD @ 5%	0.35	0.31	0.33
S.Ed. (±)	0.12	0.14	0.13

CONCLUSION

The findings of present study concluded that among nine treatment combination the best results were obtained with treatment T₉ [RDF @ 100 % + Vermicompost @ 6 t ha⁻¹ + Neem cake @ 1.2 t ha⁻¹] followed by treatment T₈ [RDF @ 100 % + Vermicompost @ 3 t ha⁻¹ + Neem cake @ 0.6 t ha⁻¹]. It proved that T₉ gave significantly higher result in respect to plant height, number of branches, potato tuber and haulm yield than other treatments. Hence it is being recommended to farmers for higher benefits and maintaining soil health.

REFERENCES

- Alam, M. N., Jahan, M. S., Ali, M. K., Ashraf, M. A. and Islam, M. K. (2007)** Effect of vermicompost and chemical fertilizers on growth, yield and yield components of potato in barind soils of Bangladesh. *J. Appl. Sci. Res.*,3(12): 1879-1888.
- Ansari, A.A., (2008)** Effect of vermicompost on the productivity of potato (*Solanum tuberosum*), spinach (*Spinacia oleracea*) and turnip (*Brassica campestris*). *World Journal of Agricultural Sciences* 4 (3):333-336.
- Arora S. (2008).** Balanced nutrition for sustainable crop production. *Krishi World (Pulse of Indian Agriculture)*. pp. *Int.J.Curr.Microbiol.App.Sci* (2017) 6(12): 4118-4125 4124 1-5.
- Banerjee, H., Sarkar, S., Ray, K., Rana,L. and Chakraborty, A. (2016)** Integrated nutrient management in potato based cropping system in alluvial soil of West Bengal. *Annals of Plant and Soil Research*. 18 (1) : 8-13.
- Barman, K. S., Kumar, A., Kasera ,S ,. and Ram ,B.(2018)** Integrated nutrient management in potato (*Solanum tuberosum*) cv. Kufri Ashoka. *Journal of Pharmacognosy and Phytochemistry* 2018; SP1: 1936-1938
- Brijesh, K. S., Kumar, A., Kasera, S. and Ram, B. (2017)** Integrated nutrient

management in potato (*Solanumtuberosum*) cv. *KufriAshoka*. *Journal of Pharmacognosy and Phytochemistry*, SP1:1936-1938.

Chakarbarti and Singh (2004) Effect of integrated nitrogen management through vermicompost and urea on growth and productivity of potato in red and lateritic soil. *Indian Agriculture*.**48**(3-4):171-174.

Dasgupta, S., Sarkar, A., Chaitanya, A.K., Saha, A., Dey, A. and Mondal, R. (2017) Response of potato crop to integrated nutrient management in the indo-gangetic alluvial soils of West Bengal, India. *Journal of Experimental Agriculture International*, 16(3): 1-10.

Dev, A., KumarS., Kumar, D., Patel, V.K., Kumar, A., Sahu, R.K. and Singh, P. (2020) The Effect of Integrated Nutrient Management (INM) and Zn Fertilization on Yield of Potato. *International Journal of Current Microbiology and Applied Sciences* Volume 9 No 4.

GangelePriyanka, (2017) Effect of potassium levels and its uptake on correlation between tuber yield and yield attributing characters in potato (*Solanumtuberosum*L.) var. *Kufri Pukhraj*. *Asian Journal of Horticulture*.**7**(2): 392-396.

Ghosh, M., Chottopadhy, G.N., Baral, K. and Munsu, P. S. (1999) Possibility of using vermicompost in Agriculture for reconciling sustainability with productivity. *Proceeding of the seminar on Agro-technology and Environment*.64-68.

Goswami Pooja., Vishwakarma,S.k. and Upadhyay,V.B. (2019) Organic farming package for rice-potato cropping system. *Journal of Pharmacognosy and Phytochemistry* 2019; 8(1): 962-967

Habibi and Thomas (2016) Effect of FYM and chemical fertilizers on yield and economics of potato-based sequences in Lahual valley of Himachal Pradesh. *Potato Journal*. **31**(3- 4): 191-193.

Habibi, F. H. and Thomas, T. (2016) Effect of different level of Fertilizers and Neem cake on attributes and yield of potato (*Solanumtuberosum* L.). *International Journal of Multidisciplinary Research and Development*,

3(4): 196-199.

Islam, M. M., Akhter, S., Majid, N. M., JannatulFerdous, J. F. and Alam, M. S. (2017) Integrated nutrient management for potato (*Solanumtuberosum*) in grey terrace soil (AricAlbaquipt). *Australian journal of crop science*.7(9): 1235-1241.

Islam, M.R., Hoque, Tahsina,S., Islam, S., Ahmed, M. and Hoque, M. (2021) Performance of different organic manures with chemical fertilizers in increasing growth, yield and nutritional quality of potato(*Solanum tuberosum*L.). *Bangladesh J. Bot.* 50(3): 651-657.

Kanwar and Paliyal (2005) Effect of different levels of nitrogen and potassium on growth, yield and biochemical composition of potatoes variety Kufri Jawahar. *Environment and Ecology*.24 (2): 268-271.

Kugedera, A.T. (2019) Assessing the effect of cattle manure and reduced ratesof nitrogen (N) and potassium (K₂O) as integrated nutrient management options on growth and yield of potatoes. *International Journal of Agricultural Sciences and Veterinary Medicine*. Vol. 7(4).

Kumar M., Baishaya L. K., Ghosh D. C., Gupta V. K., Dubey S. K., Das A., Patel D. P. (2014) Productivity and Soil Health of Potato (*Solanumtuberosum*L.) Field as Influenced by Organic Manures, Inorganic Fertilizers and Biofertilizers under High Altitudes of Eastern Himalayas. *Journal of Agricultural Science*.4(5): 223-234.

Kumar R. and Singh, N. D. (2016) Effect of inorganic and organic sources of nutrients on nutrient uptake, yield and economics of processing potato (*Solanum tuberosum* L.). *International Journal of Advanced Research*. 4(4): 498-503.

Kumar R. and Singh, N. D. (2016) Effect of Inorganic and Organic Sources of Nutrients on Nutrient Uptake, Yield and Economics of Processing Potato (*Solanumtuberosum* L.). *International Journal of Advanced Research*. 4(4): 498- 503.

- Kumar, M., Baishaya, L.K., Ghosh, D.C., Gupta, V.K., Dubey, S.K., Das A. and Patel, D.P. (2012)** Productivity and soil health of potato (*Solanumtuberosum* L.) field as influenced by organic manures, inorganic fertilizers and biofertilizers under high altitudes of Eastern Himalayas. *Journal of Agricultural Science* 4: 223-234.
- Kumar, M., Baishya, L.K., Ghosh, D.C. And Gupta, V.K. (2011)** Yield and quality of potato (*Solanum tuberosum*) tubers as influenced by nutrient sources under rainfed condition of Meghalaya. *Indian Journal of Agronomy* 56(3): 105-111.
- Kumar, S.K., Singh, B.P., Singh, S.V. and Kumar, D. (2007)** Effect of nitrogen rate on growth, yield, economic and crisps quality of Indian potato processing cultivars. *Potato Res.*, 50(2): 143-155.
- Kumar, V., Vyakaranahal, B. S., Basavaraj, N., Birbal and Raikar, S. D. (2009)** Effect of intra-row spacing and nutrient level on growth and yield of potato (*Solanum tuberosum*). *Indian J. Agril.Sci.*79(1):61-64.
- Kushwah, V.S., Singh, S.P. and Lal, S.S. (2005)** Effect of manures and fertilizers on potato (*Solanumtuberosum*) production. *Potato Journal.*32(3-4): 157-158.
- Meena, B.P., Kumar, A., Shiva, D., Paul, S. and Kumar, A. (2016)** Productivity, nutrient uptake and quality of popcorn and potato in relation to organic nutrient management practices. *Ann. Agric. Res. New Series Vol.37 (1):* 72-79.
- Mehdi, M., Saleem, T., Rai, H.K., Mir, M.S. and Rai, G. (2008)** Effect of nitrogen and FYM interaction on yield and yield traits of potato genotypes under Ladakh condition. *Potato J.*, 35 (3-4):126-129.
- Narayan sumati (2010)** Effect of planting dates and integrated nutrient management on productivity and profitability of potato (*Solanum tuberosum*) in Kashmir valley. *Indian Journal of Agronomy.*59(1): 145-150.
- Pandit, B.P., Kumar, A., Dotaniya, M.L., Jat, N.K. and Lal, B. (2018)** Effect of organic sources of nutrients on tuber bulking rate, grades and specific

gravity of potato tubers. *The National Academy of Sciences* 86(1): 47–53.

Panwar and Wani (2014) Effect of inorganic and organic sources of nutrients on nutrient uptake, yield and economics of processing potato (*Solanum tuberosum* L.) *International journal of advanced research*.4(4): 498-503.

Patel, A., Gurjar, P.K.S. and Patel, P. (2022) Study on the effect of organic manures and bio-fertilizers on growth, yield and quality of Potato (*Solanum tuberosum* L.) *The Pharma Innovation Journal*; 11(2): 507-511.

Patel, C.K., Chaudhari, P.P., Patel, R.N. and Patel, N.H. (2010) Integrated nutrients management in potato based cropping systems in North Gujarat. *Potato J.* 37(1-2): 68-70.

Raghav, M. and Kamal, S. (2009) Effect of organic sources of nutrients on potato production in Tarai region of Uttarakhand. *Pant Nagar Journal of Research* 7: 69-72.

Rao, S. (1999) Soil and environmental pollution – A threat to sustainable agriculture. 47: 611–633.

Reddy, T.Y. and G.H.S. Reddi, (2002) Mineral nutrition, manures and fertilizers. In: *Principles of Agronomy* (3rd ed). pp: 204-256. Kalyani Publishers, Ludhiana, India.

Sarkar, A., Sarkar, S., Zaman, A. and Devi, W.P. (2011) Productivity and profitability of different cultivars of potato (*Solanum tuberosum* L.) as affected by organic and inorganic sources of nutrients. *Indian Journal of Agronomy*.56(2): 159-163.

Shambhavi, S. and Sharma R.P. (2008) Influence of vermicompost on quality of potato (*Solanum Tuberosum*) in wet temperate zone of Himachal Pradesh. *Indian J. Plant Physiol.*, Vol. 13, No. 2, (N.S.) pp. 185-190 (April-June, 2008)

Shekhawat and Naik (1992) Effect of different manures along with nitrogenous fertilizers on the growth and tuber yield of potato. *The Horticulture Journal*.5(2): 121-126.

- Sikder, G., Banjare, S. and Verma, S.K. (2017)** Potato crop growth and yield response to different levels of nitrogen under Chhattisgarh plains agro-climatic zone. *Indian Journal of Science and Technology*.7(10): 1504–1508.
- Singh, S.K. and Lal, S.S. (2012)** Effect of potassium nutrition on potato yield, quality and nutrient use efficiency under varied levels of nitrogen application. *Potato J.*,39(2):155- 165.
- Srivastava, D.C.J. (2015)** Response of Levels of Inorganic Fertilizer with Organic Manure on Potato in Aquic Hapludoll of Himalayan Foothills. *Indian Journal of Hill Farming*. 28(1): 27-34.
- Tagoe, S. O., Horiuchi, T. and Matsui, T. (2008)** Effects of carbonized and dried chicken manures on the growth, yield, and N content of soybean *Plant and Soil* 306(1): 211-220.
- Taha, Malik, T. P., Bhatia, A. K. and Deswal, S. (2017)** Tuber Growth and Quality of Potato var. Kufri Bahar as Affected by FYM, Vermicompost and Neem Cake under Western Haryana Conditions, India.*Int. J. Curr. Microbiol. App. Sci*; 6(12): 4118-4125.
- Tiwari, A.,Kumar, R.,Prakash, V.,Pandey, S.R.,Pathak, D.and Kumar, N. (2021)** Effect of organic manures on potato yield, nutrients uptake and soil fertility. *The Pharma Innovation Journal*, 10(5): 1561-1563.
- Walkley, A. and Black, I. A. (1947)** Estimation of soil organic carbon by the chromic acid titration method. *Soil Science*. 47: 29-38.
- Yourtchi, M.S., Hadi, M.H.S., and Darzi, M.T. (2013)** Effect of nitrogen fertilizer and vermicompost on vegetative growth, yield and NPK uptake by tuber of potato (Agria cv.). *Intl. J. Agri. Crop Sci.*,5 (18):2033-2040.