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Integrated nutrient management in potato (*Solanum tuberosum*) cv. Kufri Ashoka

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Abstract
A field experiment was conducted in order to explore the possibility of improving, growth and tuber yield of potato by the use of integrated nutrient management. Results obtained after statistical analysis of data revealed that the height of plant, number of compound leaves/hill, number of haulms/hill, yield attributes and yield. Further number of A, B, C and D grade tubers/plot, percent of A, B, C and D grade tubers/plot, yield of A, B, C and D grade tubers/plot (kg), total number of tubers plot, total weight of tubers per plot (kg) and tuber yield (t/ha) showed the beneficial response by the use of integrated levels of NPK, FYM, Vermicompost and Neem Cake, however, on the basis of pooled data it was also further observed that the application of 150:100:120 kg NPK, 20 t FYM, 5 ton Vermicompost and 3 ton Neem Cake/ha brought paramount of improvement in growth and tuber yield of potato.

Keywords: INM, Tuber yield, growth, FYM, Vermicompost, Potato

Introduction
Potato (*Solanum tuberosum* L.) belongs to family Solanaceae. Peru- Bolivian region in the Andes (South America) is the centre of origin of potato and it has introduced to India in 17th century by Portuguese traders or the Britishers and gradually become a commercial crop of all over India. Potato is one of the major vegetable crops of the India and occupies an important position among food crops and provides staple food stuff for millions of people of many part of the world. It is grown as a cash crop and capable in producing more food per unit area and time than cereals in short span of life.

India contributes 10-11 percent of the world potato production and is the second largest producer of potato after China which enjoys a share of 26 percent of the total cultivated area. India produces about 36.4mt of potato from an area of 1.8mha. Among the states, Uttar Pradesh is the leading state with annual production of 13.45mt of potato from 0.54mha area and the productivity of India respectively (Anon., 2010) [1]. Uttar Pradesh is 20.25 and 24.90 t/ha (Chadha, 2000) [3].

In recognition of virtues the importance of potato as a staple food the FAO head declared 2008 as the 'International Year of the Potato' and has rightly identified as 'food of future'. To avoid wastage of previous natural resource and minimize the environmental damage there is need to develop and demonstrate balance use of chemical fertilizers to improve the crop production economically in sustainable ways.

Potato is a heavy feeder of nutrients and the higher food production needs higher amount of plant nutrients. As no single source is capable of supply the required quantity of nutrients, the integration of all available resources is essentially resupplying balance nutrition of plants, which should be aimed at increasing yield, nutrients deficiencies, improving lasting soil fertility restoring fertility and productivity that has been regarded by wrong and exploitive activities in the past.

Vermicompost as well as farm yard manure (FYM) influences the physico-chemical as well biological properties of the soil, which in turn improves the soil fertility, provide excellent soil structure, porosity, aeration, drainage, water retention capacity and prevent soil degradation. Similarly neem cake has a higher nutrient content (7.8% total) as compared to FYM (1.2 % total). It is also used for controlling nematodes and other soil borne organisms and boost up the crop yield. Neem cake contains 5.22 % N, 1.08 % P_2O_5 and 1.48 % K_2O. Nevertheless a lot of integrated approach have been made for pushing up the production of vegetable crops, however, work done on potato crop is meagre. Therefore, the present investigation was done to find work out the effect of integrated nutrient management in potato.

Materials and methods
The experiment was conducted during the winter season of 2010-11 and 2011-12 at Main

Experiment Station, Department of Vegetable Science, Narandra Deva University of Agriculture and Technology, Narandra Nagar (Kumarganj), Faizabad (U.P.) India.

Geographically, the experimental site falls under humid, subtropical climate and is located at 26.47^0 N latitude and 82.12^0 E longitudes on an elevation of about 113 meters above mean sea level in the Indo-gangetic alluvial plains of eastern Uttar Pradesh. Faizabad region receives a mean annual precipitation of about 1200 mm. Maximum rainfall in this area is received from mid June to end of September. The experiment was laid out in randomized block design and replicated three times. The seven treatment combinations allocated randomly in each plot in such a way that each and every plot received only once within the replication. The recommended dose of NPK was 150:100:120 kg/ha nitrogen fertilizers were applied as per treatments under study at the last ploughing, the whole quantity of organic manure (FYM, Vermicompost, Neem cake) was incorporated in the soil as per treatment. The seed of potato were planted in well prepared plots on 21th and 18th November during the year 2010-11 and 2011-12. The tubers were planted on the surface at spacing of 60 cm x 20 cm and covered with soil to make the ridges.

Indofil M-45 @ 2 kg/ha was sprayed against late blight disease. Haulms cutting was done on 24th February (2010-11) and in 22th February (2011-12). Five plants per plot were selected randomly and tagged for recoding various observations on growth and yield parameters. The statistical analysis of data recorded in all observations was computed by methods of analysis of variance and treatments were compared with help of critical difference as suggested by Panse and Sukhatme (1989) [8].

Results and discussion

Growth parameters

The per cent plant emergence at 30 DAP did not differ significantly due to different INM treatments. Thus 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. Satyanarayan (1983) [10] and Dandekar *et al.* (1991) [4] also not observed any significant effect of increasing levels of fertility on germination.

Application of Vermicompost @ 2.5 t/ha + half NPK through inorganic fertilizer produced maximum number of haulms per hill over rest of the INM treatment during both the years. Though numbers of haulms per hill depends on the number of buds present on the seed tubers, their survival with the plant growth will depend 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 of haulms / hill. The positive and significant effect on nitrogen, phosphorus and potash on number of haulms per hill has been also reported by Gupta and Pal (1989) [5]. Sahota and Govindakrishnan (1984) also reported that phosphorus application at planting improved number of haulms per hill.

The plant height and number of compound leaves per plant showed statistically significant response to integrated nutrient management during the present investigation. The maximum number of haulms per plant, plant height and number of compound leaves was recorded under treatment T_5 (Vermicompost @ 2.5 t/ha + half NPK through inorganic fertilizer) whereas, the minimum number of haulms per plant, plant height and of compound leaves per plant were observed under treatment T_6 (Neem cake @ 3 t/ha). Similar finding have been reported by Mondal *et al*., 2005 [7] during both the years. Minimum height and leaves were recorded with T_3 treatment. Similar findings have also been reported. The increase in height by the use of vermicompost with integration of NPK might due to the influence of nitrification inhibition properties of vermicompost in the soil. Besides, it may also be due to rapid elongation and multiplication of cell in the presence of adequate quantity of nitrogen. Sahota and Grewal (1969) and Singh and Singh (1994) [11] also reported beneficial effect of nitrogen application on biomass productionof potato. The increase in growth parameters might be because of batter photosynthetic area. Since nitrogen is one of the basic minerals associated with synthesis of protoplasm and in primary synthesis of amino acid. It also increases meristematic activity at faster rate under higher fertility which causes batter plant growth. It is also an established fact that plant supplied with abundant nitrogen and phosphorus would assimilate more photosynthates and batter translocation resulting in higher vegetative growth.

Table 1: Effect of Integrated nutrient management on growth parameters of potato (*Solanum tuberosum*) cv. Kufri Ashoka (Pooled data of two year 2010-11 and 2011-12.

Treatments	Growth parameters					
	Emergence per cent at 30 DAP	Number of haulms/hill	Plant height		Number of compounds leaves/hill	
			45 Dap	60 Dap	45 Dap	60 Dap
T1	93.07	7.28	28.55	38.02	60.48	86.70
T2	92.91	6.75	24.70	33.01	54.80	78.30
T3	94.48	8.00	28.18	37.61	57.40	85.67
T4	92.71	7.47	25.75	33.82	56.36	80.46
T5	95.28	8.81	29.83	39.77	61.00	87.63
T6	93.97	6.56	24.76	32.79	54.02	77.18
T7	93.79	7.79	27.97	37.31	55.53	83.53
SEm±	1.61	0.32	0.81	1.55	1.67	2.36
C.D. P=0.05)	NS	1.02	2.51	4.78	5.15	7.28

Yield attributes and Yield

Under present investigation they worked influence of various INM treatments was noticed on the yield attributes of potato. Significant increased towards number and weight of B grade tubers was recorded under treatment T_5 (Vermicompost @ 2.5 t/ha + half NPK through inorganic fertilizer) followed by T_3 (FYM @ 10 t/ha + half NPK through inorganic fertilizer).

Table 2: Effect of Integrated nutrient management on yield parameters of potato (*Solanum tuberosum*) cv. Kufri Ashoka (Pooled data of two year 2010-11 and 2011-12.

Treatment	Yield attributing and yield							
	Number of tubers (A, B, C and D grade) per plot				Percent of A, B, C and D grade tubers per plot			
	A-grade (>75g)	B - grade (50-75g)	C -grade (25-50g)	D - grade (0-25g)	A-grade (>75g)	B - grade (50-75g)	C-grade (25-50g)	D - grade (0-25g)
T1	87.84	222.83	211.33	132.50	13.45	34.02	32.35	20.17
T2	89.16	190.33	181.33	112.00	15.57	33.21	31.66	19.55
T3	75.00	229.83	216.83	136.66	11.42	34.96	32.97	20.64
T4	86.67	215.84	216.00	127.50	13.43	33.42	33.43	19.70
T5	86.00	230.66	173.00	137.50	13.76	36.64	27.60	21.98
T6	72.00	181.50	213.67	107.00	12.57	31.61	37.19	18.62
T7	89.50	225.33	214.17	131.50	13.55	34.07	32.34	19.96
SEm±	3.23	10.53	6.73	5.26	0.53	1.18	0.69	0.92
C.D. P=0.05)	9.95	32.47	20.75	16.20	1.65	5.15	2.12	2.85

The probable region for favorable increase in yield attributes owing to the application of vermicompost, FYM and NPK could use attributed to well-developed root system which ultimately resulted in a healthy plant system. Results on weight of tubers and total yield of potato tuber indicated that joint application of organic, inorganic and bio-fertilizers have better effect and improvement in these parameters might due to secretion of certain growth regulator like. IAA and GA_3 in turn might have improved the yield parameters. Similar observations have also been noted by Kushwah and Banafar (2003) [6], Bhowmik and Dandapat (1991a) [2], Raghav and Chandra (2005) [9] and Singh and Rai (2007) [12].

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