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Effect of different level of Fertilizers and Neem cake on attributes and yield of potato (*Solanum tuberosum* L.)

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Abstract
The field experiment was carried out at soil science research farm of Sam Higginbottom institute of Agriculture, Technology and Sciences (deemed to be university) Allahabad, during Rabi season in the year 2015-2016. The result obtained with treatment T_8-[NPK 100% RDF + Neem cake 100 kg/ha] was found to be significant among other treatments in potato cultivation and soil quality improvement. It was also revealed that the application of Nitrogen with Neem cake were excellent source for fertilization than fertilizers. The treatment (T_8) also showed greater benefit cost ratio followed by other treatments.

Keywords: Nanotechnology, Thin Film technology, Nanofabrics, Optical coating, sensors

1. Introduction

Potato belongs to the genus *Solanum* in the family of Solanaceae. The commercially cultivated potato belongs to the species *Solanum Tubersoum*. Potato is the most important food crop in the world. The potato is a crop which has always been the poor man's friend. Potato is being cultivated in the country for last more than 300 years for vegetable purpose it has become one of the most popular crop in this country. The probable centre of origin of potato is in South America in the central Andean region. Evidences indicate that a potato was cultivated for countries by South American Indians and the tubers were used a command article of food. The Spanish people brought potato from peru to Spain in 1565, they were probably to England about 1586 by Sir Francis Darke. Following its introduction into European agriculture, potato becomes an important food crop to Italy, France and Ireland. During the famine years, the potato crop became a valuable food crop in Ireland. Potato was introduced to India from Europe in the beginning of the 17th century. China is now the world's largest potato producing country and nearly a third of the world's potato are harvested in china and India (Singh, 2010) [1].

India ranks third in area and fourth in production of potato. The major potato growing area falls in the indo-gangetic plain which account for about 80 per cent of total production. (Khurana and Naik 2002) [2].

In India in grown in almost all the state. Comprising Punjab, Haryana, Uttar Pradesh, Bihar and West Bengal. Uttar Pradesh has the largest area and production of potato followed by West Bengal and Bihar. Gujarat has the highest productivity in India. Potato contributes about 1.23% of the gross production from agricultural and direct activities India.

In Afghanistan help alleviate hunger and malnutrition in less developed countries (Guenthner, 2010 and Thiele *et.al,* 2010) and the crop is attaining higher importance at faster rate in many of the Asian countries (Scott and Suarez, 2011; 2012). In Afghanistan, potato is the second most important staple food crop after wheat. It is grown in an area of 21,900 ha producing 333,600 t/atan average productivity of 15.23 t/ha (FAOSTAT, 2012). It is grown in provinces like Bamyan, Ghazni, Helmand, Kunduz, Badakhshan, Wardak, Parwan, Nangrhar,panjsher,atc. The most popular potato varieties grown in Afghanistan are Safed gul, Be gul, Sabz gul, Sorkh gul (Lavkar), Chandramukhi, Cardinal and Desiree. Chandramukhi, Lavkar, Cardinal and Desiree are exotic varieties imported from India in 2002. In 2003 the International Potato Center (CIP) also introduced three new potato varieties - Kufri Jyoti, Kufri Badshah and Diamond in Nangarhar province.

Potato consumption has increased in the developing countries and over the last decade, global potato production has increased at an annual average rate of 4.5 percent (FAO, 2007) [4].

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 corps. Neem Cake Organic Manure has more nitrogen, phosphorous, potassium, calcium and magnesium than the farmyard manures. It is rich is 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 %.

Potassium enhances potato plant height, resistance against drought, frost and diseases, tuber yield and also develops the quality of potato tubers. For a bumper potato crop potassium is essentially required. In this way plant nutrient requirement, potato yield and quality are affected by potassium application. Potassium is involved in the activation of a no. of enzymes, metabolic activities and translocation of photosynthate to the tubers, thus increasing yield of potato.

The 100g of raw potato with skin has nutritional value having energy 34 KJ (77 Kcal), carbohydrates 19g (Starch 15g, dietary fiber 2.2g), fat 0.1g, protein 2.0g, water 75g, thiamine (Vit, B1) 0.08mg (6%), riboflavin (Vit. B2) 0.03mg (2%), niacin (Vit. B3) 1.1mg (7%), Vitamin B6 0.25mg (19%), Vitamin-C 20mg

(33%), calcium 12mg (1%), iron 1.8mg (14%), magnesium 23mg (6%), Phosphorus 57mg (8%) Potassium 421 mg (9%) sodium 6mg.

2. Materials and methods

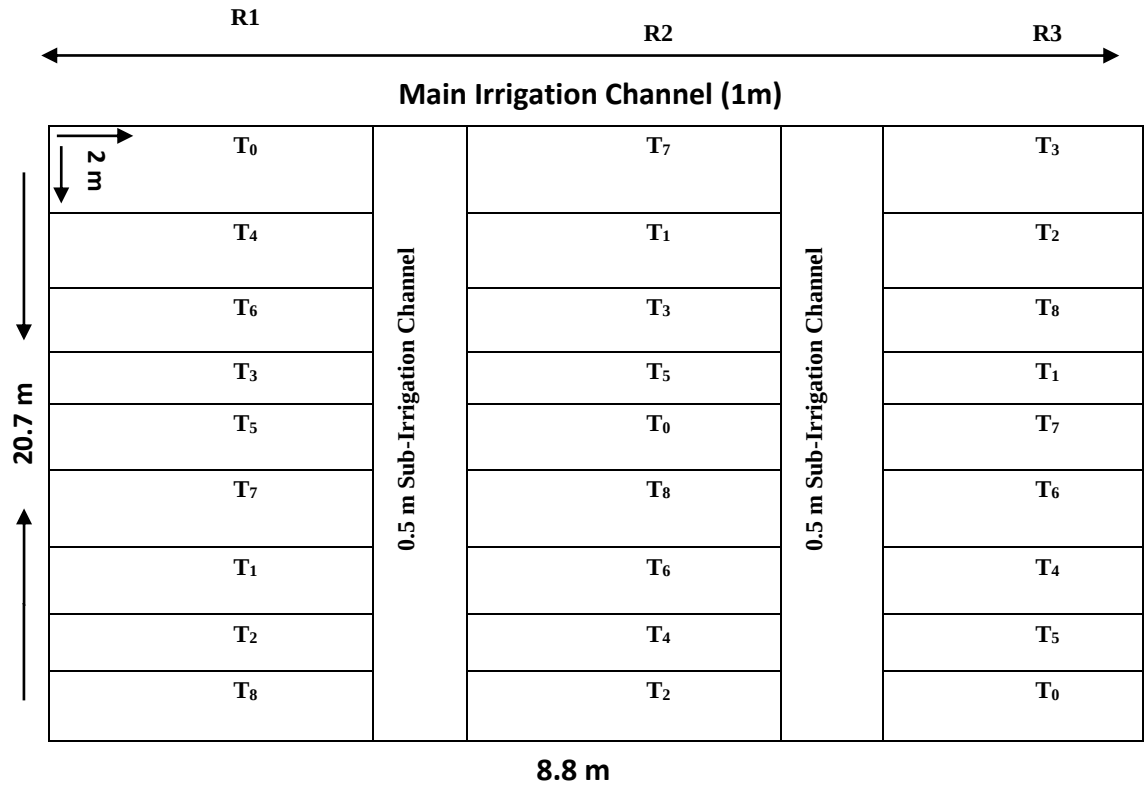
2.1 Study Area

The experimental site was situated in university campus jurisdiction in district Allahabad, U.P. The soil of this site belongs to order entisol having textural class sandy loam. The details of treatments and other relevant information are given below

(i) Treatment combinations

T_o	@ [NPK 0% RDF + Neem Cake 0 kg/ha]
T_1	@ [NPK 0% RDF + Neem Cake 50 kg/ha]
T_2	@ [NPK 0% RDF + Neem Cake 100 kg/ha]
T_3	@ [NPK 50% RDF + Neem Cake 0 kg/ha]
T_4	@ [NPK 50% RDF + Neem Cake 50 kg/ha]
T_5	@ [NPK 50% RDF + Neem Cake 100 kg/ha]
T_6	@ [NPK 100% RDF + Neem Cake 0 kg/ha]
T_7	@ [NPK 100% RDF + Neem Cake 50 kg/ha]
T_8	@ [NPK 100% RDF + Neem Cake 100 kg/ha]

(ii) Layout plan of experimental sites



(iii) Detail of the experiment

- Crop = Potato
- Variety = Kufri Badshah
- Season = Rabi
- No. of replication = 03
- No. of plots in each replication = 09
- Total No. of plots = 27
- Plot size = 2x2m^2
- Width of main irrigation channel= 1m
- Width of sub irrigation channel = 0.5m
- Width of bound = 0.3m
- Gross cultivated area = 184.8m^2
- Net cultivated area = 108m^2
- Design of experiment = 3x3Factorial RBD

(iv) Recommended dose of fertilizer (RDF) for potato.

S. No.	Source of fertilizers	RDF
1	Urea + DAP	N at 120 kg ha^{-1}
2	DAP	P_2O_5 at 100 kg ha^{-1}
3	MOP	K_2O at 120 kg ha^{-1}
4	Neem Cake	1250 kg ha^{-1}

2.2 Calendar of field operation for experiment

2.1	Operation	Date	Remarks
2.2	ploughing	24.10.2015	Ploughing was done to bring soil to fine tilth.
2.3	Layout	25.10.2015	Manual labour was cmployed
2.4	Making of bonds and leveling of plots	26.10.2015	Bunds and leveling of plots were done manually.
2.5	Fertilizer appliction	27.10.2015	Application of Neem cake before sowing were done.
2.6	Sowing of potato	28.10.2015	potato,Kufri Badshah seeds was sown on the ridges at arow to roe distance of 45cm and plant to plant distance of 15cm.
2.7	1 st Weeding	10.11.2015	Weeding was done by hand.
2.8	First Irrigation	20.11.2015	Light irrigation was given within 23days of sowing.
2.9	Seccond Irrigation	10.12.2015	Light irrigation was given within 43days of sowing.
3.0	2nd weeding	14.12.215	Weeding was done by hand.
3.1	Third Irrigation	30.12.2015	Light irrigation was given within 64days of sowing.
3.2	Fourth Irrigation	25.01.2016	Light irrigation was given within 90days of sowing.
3.3	Harvesting	02.02.2016	The harvesting was done plot wise at maturity stage.

Weekly meteorological data during experimental period (Oct. 2015-Feb. 2016).

Week/month	Temperature (oC)		Relative humidity (%)		Rainfall(mm)
	Max.	Min.	Max.	Min.	
November 2015					
45th week	35.6	19	92	52	4.5
46th week	32.2	20.2	92	60	0
47th week	35	19.6	90	49	0
48th week	31.4	10	92	50	0
December 2015					
49th week	27.2	13	96	70	0
50th week	25.4	10	92	65	0
51th week	25.6	9.6	90	63	0
52th week	24.6	10	94	56	0
January 2016					
1st week	25.8	10	90	54	0
2st week	27.4	12	90	50	0
3st week	19.6	12.4	92	64	8.6
4st week	26.2	8.6	91	51	0
February 2016					
5th week	31	11	90	46	0

Source: Agro meteorological Unit, School of forestry & Environment, SHIATS, Allahabad.

3. Result and Discussion

3.1 Attributes

3.1.1 Plant height (cm)

At 30 DAS, the maximum 18.04 cm in T_8-[NPK 100% RDF + Neem Cake 100 kg/ha], followed by T_7- [NPK 100% RDF + Neem Cake 50 kg/ha] was 16.70 cm and minimum height was observed in T_0 (control) that is 10.43 cm. At 60 DAS, the maximum 34.83 cm in T_8-[NPK 100% RDF + Neem Cake 100 kg/ha], followed by T_7- [NPK 100% RDF + Neem Cake 50 kg/ha] was 32.83 cm and minimum height was observed in T_0 (control) that is 22.84 cm. At 90 DAS the maximum 52.32 cm in T_8-[NPK 100% RDF + Neem Cake 100 kg/ha], followed by T_7- [NPK 100% RDF + Neem Cake 50 kg/ha] the plant height was 51.06 cm and minimum height was observed in T_0 (control) that is 35.34 cm.

3.1.2 Number of leaves

At 30 DAS, the maximum 19.17 in T_8-[NPK 100% RDF + Neem cake 100 kg/ha], followed by T_7- [NPK 100% RDF + Neem Cake 50 kg/ha] the number of leaves was 16.95 and minimum number of leaves was observed in T_0 (control) that is 10.02. At 60 DAS, the maximum 61.17 in T_8-[NPK 100% RDF + Neem cake 100 kg/ha], followed by T_7- [NPK 100% RDF + Neem cake 50 kg/ha] the number of leaves was 57.06 an minimum number of leaves was observed in T_0 (control) that is 34.57. At 90 DAS the maximum 81.50 in T_8-[NPK 100% RDF + Neem cake 100 kg/ha], followed by T_7- [NPK 100% RDF + Neem cake 50 kg/ha] the number of leaves was 79.72 and minimum number of leaves was observed in T_0 (control) that is 55.02.

3.1.3 Number of branches per plant

At 30 DAS, the maximum 4.84 in T_8-[NPK 100% RDF + Neem cake 100 kg/ha], followed by T_7- [NPK 100% RDF + Neem Cake 50 kg/ha] the number of branches was 4.50 and minimum number of branches was observed in T_0 (control) that is 2.72. At 60 DAS, the maximum 10.17 in T_8-[NPK 100% RDF + Neem cake 100 kg/ha], followed by T_7- [NPK 100% RDF + Neem cake 50 kg/ha] the number of branches was 8.61 a minimum number of branches was observed in treatment combination T_0 (control) that is 7.73. At 90 DAS the maximum 12.84 in T_8-[NPK 100% RDF + Neem cake 100 kg/ha], followed by T_7- [NPK 100% RDF + Neem cake 50 kg/ha] the number of branches were 12.28 and minimum number of branches were observed in T_0 (control) that is 10.84.

3.1.4 Number of tubers per plant

The maximum number of tubers per plant of were reported in T_8-[NPK 100% RDF + Neem cake 100 kg/ha] with 4.06 followed by T_7- [NPK 100% RDF + Neem cake 50 kg/ha] with 3.73 and the minimum number of tuber per plant with 2.17 were recorded in T_0 (Control).

3.2 Yield

The maximum number of tubers yield were reported in treatment T_8-[NPK 100% RDF + Neem cake 100 kg/ha] with 70.73 t ha^{-1} followed by T_7- [NPK 100% RDF + Neem cake 50 kg/ha] with 33.12 t ha^{-1} and the minimum tubers yield with 12.34 t ha^{-1} were recorded in T_0 (Control). The tubers yield of potato were found to be significant, potatoes cv. Kufri Chandramukhi grown in sandy loam soil and given no fertilizer or 100 kg N, N+ 50 kg P, NP + 100 kg K or 150 kg N + PK/ha gave tuber yields 40.56 t ha^{-1} and 32.95 t ha^{-1} respectively .

3.3 Economcis of different treatment combination for cultivation of potato (*Solanum tuberosum* L.)

Treatments	Cost of cultivation (Rs/ha)	Total yield of per plot (kg)	Selling Rate (Rs/t)	Gross return (Rs/ha)	Net return Rs./ha)	Benefit cost ratio
T_0	77209.60	12.34	8500.00	104890.00	27680.40	1.36
T1	96709.60	19.73	8500.00	167705.00	70995.40	1.73
T2	116209.60	20.67	8500.00	175695.00	59485.40	1.51
T3	80795.52	15.96	8500.00	135660.00	54864.48	1.68
T4	100295.52	25.78	8500.00	219130.00	118834.48	2.18
T5	119795.52	33.12	8500.00	281520.00	161724.48	2.35
T6	84364.80	19.56	8500.00	166260.00	81895.20	1.97
T7	103864.80	31.50	8500.00	267750.00	163885.20	2.58
T8	123364.80	40.73	8500.00	346205.00	222840.20	2.81

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