International Journal of Agriculture Sciences
ISSN: 0975-3710&E-ISSN: 0975-9107, Volume 10, Issue 5, 2018, pp.-5319-5321.
Available online at http://www.bioinfopublication.org/jouarchive.php?opt=&jouid=BPJ0000217

Research Article

EFFECT OF NITROGEN, PHOSPHORUS AND POTASSIUM ON GROWTH AND YIELD OF POTATO (*Solanum tuberosum* L.)

SINGH BEANT, SINGH S.K.*, KAUR RAJNEET AND RAMPARTAP

Department of Agriculture, Mata Gujri College, Fatehgarh Sahib, 140407, Punjabi University, Patiala, 147002, Punjab, India
*Corresponding Author: Email-sandeepkumar@matagujricollege.org

Received: March 04, 2018; Revised: March 07, 2018; Accepted: March 08, 2018; Published: March 15, 2018

Abstract- The present investigation entitled "Effect of Nitrogen, Phosphorus and Potassium on Growth and Yield of Potato (*Solanum tuberosum* L.)" was conducted during 2016-17 at the experimental farm Department of Agriculture, Mata Gujri College, Fatehgarh Sahib, Punjab, India. The experiment was laid out in a Randomized block design with three replications and nine treatments. The treatments consisted of T_1: Control, T_2: 50% NPK, T_3: 75% NPK, T_4: 100% NPK, T_5: 100% NP + 75% K, T_6: 100% NP + 50% K, T_7: 75% NP + 100% K, T_8: 75% NP + 50% K and T_9: 50% NP + 75% K. Application of different levels of fertilizers increased the growth, yield and yield attributes of Potato. The maximum plant height (69.02 cm), Number of compound leaves (54.97), Number of branches per plant (12.90), Leaf Area Index (4.36), Number of plants in running meter (8.67), Number of main stems per hill (4.17), Dry weight of Haulm (79.20g/hill), Number of tubers per plant (13.23), Weight of tubers per plant (385g), Yield of Marketable tubers (235.92q/ha), Total tuber yield (256.29q/ha), Haulm yield (87.40q/ha), Biological yield (343.70q/ha) and Harvest Index (76.17%) were recorded with the combined application of 100 per cent RDF of Nitrogen, Phosphorus and Potassium. Whereas, maximum net returns of Rs. ₹ 2,06,045 along with benefit: cost ratio (4.10:1) were also recorded with the application of 100%NPK. These results suggested that the optimum production of potato can be obtained with combined application of 100% NPK.

Keywords- Nitrogen, Phosphorous, Potassium, Growth and Yield

Citation: Singh Beant, *et al*., (2018) Effect of Nitrogen, Phosphorus and Potassium on Growth and Yield of Potato (*Solanum tuberosum* L.). International Journal of Agriculture Sciences, ISSN: 0975-3710 & E-ISSN: 0975-9107, Volume 10, Issue 5, pp.-5319-5321.

Academic Editor / Reviewer: Kumar Amogh P, Moubarak M Y Gh, Nimai Bera

Introduction

The potato (*Solanum tuberosum* L.) is a starchy, tuberous crop belongs to the family Solanaceae [1]. Potato is considered as reliable source of carbohydrates even in diabetics. Fresh potatoes along with its skin are richest source of antioxidant, vitamin-C. Potatos are richest source of calories and B-complex such as pyridoxine, thiamin, niacin, pantothenic acid and folates [2]. In India the potato production during the current year 2015-16 is estimated to be around 43417 million tons from the area of 2117 thousand hectare in the country as per the final estimate of Govt. of India. The average productivity of potato in country is 21 Million tons per hectare. In Punjab the total area under potato production is 89.99 thousand hectares with total production of about 2262.40 million tons [3]. Nitrogen, Phosphorus and Potassium are major requirements of Potatoes. Nitrogen is a first limiting nutrient in potato production thus has a great influence on crop growth, tuber yield and its quality. A mature crop of potato yielding 25-30 t per ha tubers removes 120-140 kg N per ha [4]. Phosphorus is involved in wide range of plant processes from permitting cell division to the development of a good root system as well as root growth and hastens crop maturity. Potassium application increases the size of tubers, especially, if K supply of the soil is low to medium [5]. It increases the yield by increasing the number and yield of large sized tubers. Potassium has an important role in the control of the plant water status and ionic concentrations inside plant tissues, including stomata [6]. Potato demands high level of soil nutrients due to relatively poorly developed and shallow and coarse root system in relation to yield [7]. Compared with cereal crops, potato produces much more dry matter in a shorter cycle [8].

Materials and Methods

An experiment was carried out in randomized block design with nine treatments and replicated thrice. The treatments consisted of T_1: Control, T_2: 50% NPK, T_3: 75% NPK, T_4: 100% NPK , T_5: 100% NP + 75% K, T_6: 100% NP + 50% K, T_7: 75% NP + 100% K, T_8: 75% NP + 50% K and T_9: 50% NP + 75% K. Observations were recorded from selected plants with different characters *viz;* Plant height, number of compound leaves per plant, Number of branches per plant, number of plants in running meter, Leaf area index and yield attributes *viz.,* number of tubers per plant, weight of tubers per plant, marketable tubers per plot (kg per plot), total tuber yield per plot (kg per plot), total tuber yield per hectare (q per ha), biological yield and harvest index (%). All the recommended cultural practices were adopted during the course of planting. Planting of tubers were done on 20th of October. Tubers are planted manually at a depth of 12cm below ground. Planting was done at row spacing of 70cm and plant spacing of 20cm. Nitrogen, Phosphorus and Potassium were applied in the form of Urea, MOP and SSP respectively.

Results and Discussion

Growth Attributes

Data revealed that the highest plant height at different stages of crop growth (30, 60 and 90 DAS) was observed under the treatment T_4 (31.52 cm, 47.32cm and 69.02 cm) whereas minimum was observed under T_1 (18.27 cm, 35.36 cm and 55.21 cm). This might be due to the higher dose of nitrogen which is essential element for cell division, cell enlargements and it also increases the protoplasm [9]. The increase in plant height may be due to the fact that higher nitrogen

concentration stimulated the assimilation of carbohydrates and protein, which in turn enhanced cell division and formation of more tissues that resulted in enhanced vegetative growth of the plant as reported [10]. Higher dose of phosphorus would have been resulted in higher shoot growth [11]. Similar findings had also been reported by [12-18]. The findings regarding number of compound leaves per plant at 30, 60 and 90 DAS was maximum in T_4 *i.e.,* 40.18, 46.49 and 54.97% and minimum was found in T_1 26.05, 29.60 and 31.31%. The increase in number of compound leaves may be due to higher uptake of nutrients in those treatments which may have resulted in increased synthesis of carbohydrates utilized in building up of new cells [19]. Similar results were also found by [12]. and [20]. Number of branches per plant was remarkably influenced by different levels of NPK. The maximum number of branches per plant at 30, 60 and 90 DAS were found in T_4 *i.e.,* 7.53, 9.77 and 12.90 and minimum was found in T_1 1.97, 3.07 and 4.77. This might be due to higher vegetative growth of the plant observed in those treatments. Number of branches indicates the higher number of compound leaves which enables high photosynthesis. This will help in high yield and good plant stand. This character was influenced by the different levels of NPK [21].

Yield Attributes

The highest number of tubers per hill was produced with the T_4 (13.23) whereas lowest number of tubers per hill was noticed at the T_1 treatment *i.e.,* 6.70. The higher number of tubers may be due to increased absorption of nutrients in higher level of RDF which would have increased photosynthetic activity as well as translocation of photosynthates for formation of new tubers [22]. Nitrogen affects tuber formation in potato by influencing the activity and phytoharmone balance in the plants, especially on the levels of gibberellic and abscissic acids and cytokinins [23]. The maximum average weight of tubers per plant (385g) was produced from the T_4 and minimum was found from treatment T_1 (200g). Profuse vegetative growth may have resulted in accumulation of higher photosynthates in the developing tubers in those treatments (100 % RDF) which may have produced more number of large sized of tubers and thus higher weight of these large sized tubers would have resulted in higher yield of marketable tubers [24]. These results were in agreement with the findings of [25], [19]. and [26]. Similar results were also found in marketable yield of tubers. Maximum Haulm yield was obtained from the T_4 treatment (87.40q per ha) which was followed by T_5 treatment (83.33q per ha). Lowest haulm yield of 39.25q per ha was obtained from control treatment. Highest Harvest index was recorded in T_4 treatment which was followed by T_5 treatment. Lowest value of harvest index was observed in the control treatment. The variation in among harvest index in various treatments were found to be statistically non-significant among different levels of NPK. The maximum income (both gross and net) was obtained with the application of 100% RDF which was followed by 100% RDF of NP + 75% RDF of N. On other hand, the lowest income (both gross and net) was obtained with the application of 100% RDF or Control treatment. The benefit cost ratio was found highest under 100% NPK. The highest gross return and net return as well as the maximum B: C ratio found in the above treatment might may be due to an increased availability of nutrients to the plant due to application of higher levels of NPK Which may have resulted in profuse plant growth and development which ultimately might have turned in higher tuber yield per unit area. Thus, the higher tuber production in the above treatments (100% RDF) lead to higher gross as well as net income and Benefit: Cost ratio also [27].

Table-1 *Effect of different levels of NPK on Growth Attributes*

Sr. No.	Plant Height			No. of compound leaves			No. of branches per plant		
	30DAS	60 DAS	90DAS	30DAS	60 DAS	90 DAS	30DAS	60 DAS	90DAS
T_1	18.27	35.76	55.21	26.05	29.60	31.31	1.97	3.07	4.77
T_2	20.89	36.21	56.02	27.96	30.63	32.77	2.57	4.50	6.07
T_3	24.43	41.18	61.50	33.52	37.21	42.75	5.93	8.40	9.17
T_4	31.52	47.32	69.02	40.18	46.49	54.97	7.53	9.77	12.90
T_5	28.87	42.33	64.69	38.30	44.71	51.70	7.13	9.20	12.33
T_6	27.09	42.01	63.10	37.08	42.72	50.46	6.90	9.10	11.97
T_7	23.25	40.36	60.18	31	34.48	39.10	5.33	7.57	8.30
T_8	22.07	38.35	59.38	29.96	33.72	37.69	4.07	6.03	7.97
T_9	21.42	37.81	58.19	28.56	31.79	35.49	2.97	5.70	7.07
SEm (±)	1.52	1.99	2.13	1.23	1.41	1.75	0.22	0.25	0.31
CD (P = 0.05)	4.55	5.97	6.39	3.68	4.22	5.23	0.65	0.75	0.94

Table-2 *Effect of different levels of NPK on Yield Attributes*

Sr. No.	Number of tubers per plant	Weight of tubers per plant (g per plant)	Marketable Tubers Yield (kg per plot)	Total Marketable tuber yield (q per ha)	Yield of Tubers per plot (kg per plot)	Total Tuber Yield (q per ha)	Haulm yield (q per ha)	Harvest index (%)
T_1	6.70	200	6.67	74.07	10.13	112.59	39.25	73.82
T_2	8.23	288.33	8.97	99.62	13.83	153.70	46.66	74.30
T_3	10.70	293	14.73	163.70	17.53	194.81	70.37	74.55
T_4	13.23	385	21.23	235.92	23.07	256.29	87.40	76.17
T_5	12.90	356	19.03	211.48	21.37	237.40	83.33	75.23
T_6	11.23	320	16.07	178.55	19.43	215.92	76.66	74.76
T_7	9.70	281.33	12.87	142.96	16.63	184.81	64.44	74.13
T_8	9.67	258.33	11.53	128.14	15.23	169.26	57.03	74.84
T_9	9.20	239.33	10.87	120.73	14.63	162.59	51.85	74.50
SEm (±)	0.42	10.39	0.83	9.28	0.85	9.48	9.48	8.81
CD (P = 0.05)	1.26	31.14	2.50	27.82	2.56	28.43	28.43	NS

Table-3 *Effect of different levels of NPK on Nutrient content and Economics*

Sr. No.	Tuber yield (q per ha)	Total Cost of Cultivation (q per ha)	Gross return (q per ha)	Net return(q per ha)	B:C ratio
T_1	112.59	42989	112590	69601	1:61
T_2	153.70	46617	153700	107083	2:29
T_3	194.81	48431	194810	146379	3:02
T_4	256.29	50245	256290	206045	4:10
T_5	237.40	49226	237400	188174	3:82
T_6	215.92	48205	215920	167715	3:47
T_7	184.81	49451	184810	135359	2:73
T_8	169.26	47411	169260	121849	2:57
T_9	162.59	47637	162590	114953	2:41

Conclusion

From the finding of present investigation, it is concluded 100% Application of Nitrogen, Phosphorus and Potassium (NPK) have significantly influenced the growth and yield of crop. The application of 100% NPK gave best results in terms of growth and yield of potato. On the basis of results summarized above, it can be concluded that application of 100% NPK gave the best result. The lowest net income overall was in control treatment. Thus, it can be said that for obtaining maximum tuber yield as well as profit from potato tubers proper application of Nitrogen, Phosphorus and Potassium should be applied as optimum nutrition is the key to achieve maximum crop production.

Application of research: Beneficial to farmer and improve soil health

Research Category: Effect of N, P and K on Growth and Yield of Potato

Abbreviations:

NPK : Nitrogen, Phosphorus
RDF : Recommended Dose of Fertilizer
Kg : Kilogram
G : Gram
DAS : Day After Sowing
& : Percentage
B:C : Benefit Cost Ratio
q/ha : Quintal per Hectare
SEm : Standard Error due to mean
CD : Critical Differences
P : Probability
MOP : Muriate of Potash
SSP : Single Super Phosphate
Cm : Centimetre

Acknowledgement / Funding: Authors are thankful to Mata Gujri College, Fatehgarh Sahib, 140407, Punjabi University, Patiala, 147002, Punjab

***Major Advisor: Dr Sandeep Kumar Singh**
University: Punjabi University, Patiala, 147002, Punjab
Research project name or number: MSc Thesis

Author Contributions: All author equally contributed

Author statement: All authors read, reviewed, agree and approved the final manuscript

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.

References

[1] Ahmad K.U. (1977) *Potato for the Tropics. Mrs. Mumtaj Kamal, Bunglow no. 2 farm gate, Dacca*-15. Pp. 71-72, 122.
[2] Bashir U. and Qureshi F. (2005) *An International Quarterly Journal of Biology & Life Sciences,* 2(3), 786-791.
[3] NHB. (2016) Handbook of Indian Horticulture Database, NHB, Gurgaon, Haryana, India.
[4] Malik G.C. and Ghosh D.C. (2002) *Effect of fertility level, plant density and variety on growth and productivity of potato. Potato Global Research and Development Proceedings of Global Conference on potato New Delhi, India*, 2, 866-871.
[5] Bansal S.K. and Trehan S.P. (2011) *Karnataka Journal of Agriculture Science,* 24 (1), *48-54*
[6] Khan N.A., Ali N. and Rab A. (2000) *Pakistan Journal of Soil Science,* 16, 81-88.
[7] Nigussie Dechassa (2001) Phosphorus efficiency of selected vegetables. A Ph.D. Dissertation Presented to Hanover University, Fielder stadt, Germany.
[8] Singh J.P. and Trehan S.P. (1998) Balanced fertilization to increase the yield of potato. In, proceeding of the IPI-PRI-PAU workshop on "Balanced fertilization in Punjab agriculture" held at Punjab Agriculture University, Ludhiana, India 15-16 December 1997,129-139.
[9] Chettri M, Mondal S S and Konar A. (2004) *Indian Journal of Agricultural Sciences,* 74(4), 210-212.
[10] Anabasis O.A.N., Hattar B.I. and Sawwan M.A. (1997) *Dirasat Agriculture Sciences,* 24(2), 242-259.
[11] Bose U.S., Bisen A. and Nayak S. (2008) *Green Farming,* 2(1), 16-17.
[12] Debasish B., Sharma B.N. and Saikia M. (2001) *Journal of Agriculture Science Society of North East India,* 14(2), 236-239.
[13] Kumar D. and Sharma R.C. (2002) *Indian Journal of Agriculture Sciences,* 72(9), 503-507.
[14] Hossain A.B.M., Hakim M.A. and Onguso J.M. (2003) *Pakistan Journal of Biological Sciences*, 6(14), 1243-1246.
[15] Al-Moshileh A.M., Errebhi M.A. and Motawei M.I. (2005) *Emirates Journal of Agriculture Sciences,* 17(1), 01-09.
[16] Banafar R.N.S., Billore M. and Kushwah S.S. (2005) *Potato Journal,* 32, 3-4.
[17] Adhikari B.H. and Karki K.B. (2006) *Nepal Agricultre Research Journal,* 7, 42-48.
[18] Chopra S., Kanwar J.S. and Samnotra R.K. (2006) *Environment and Ecology,* 24(2), 268-271.
[19] Taya J.S., Malik Y.S., Pandita M.L. and Khurana S.C. (1994) *Journal of Indian Potato Assocication,* 21(3-4), 184-188.
[20] Yassen A., Safia A. and Adam Mand Sahar M.Z. (2011) *Australian Journal of Basic and Applied Sciences,* 5(11), 1296-1303.
[21] Sinha B. (2007) Influence of nitrogen levels on growth and tuber yield in potato. *M.Sc. (Ag) Thesis IGKV, Raipur*. pp. 70-71.
[22] Khurana S.C. and Bhutani R.D. (2005) *Potato Journal,* 32(3-4), 242.
[23] Amzallang G.N., Herner H.R. and Poljakott- Mayer A. (1992) *Journal of Experimental Botany,* 43,81-87.
[24] Nizamuddin M., Mahmood M., Khalid F. and Riaz S. (2003) *Asian Journal of Plant Science,* 2(2), 149-151.
[25] Patel B. (2013) Effect of different levels of NPK on growth, development and yield of potato cv. Kufri Ashoka under Chhattisgarh plain condition. *M. Sc. (Ag) Thesis IGKV, Raipur*. pp. 70-71.
[26] Banjare S. (2012) Study on the effect of different levels of nitrogen in the form of urea on potato production. M. Sc. (Ag) Thesis IGKV, Raipur. pp. 82-83.
[27] Chettri M., Basu A., Konar A. and Mondal A.B. (2005) *Potato Journal,* 32(3-4), 163- 164.