Journal of AgriSearch, 7(3):134-137
An Open Access International Peer Reviewed Quarterly
ISSN : 2348-8808 (Print), 2348-8867 (Online)
https://doi.org/10.21921/jas.v7i03.18686

Nitrogen Requirement of Potato for Eastern Indo-Gangetic Plain of India

SK YADAV[1]*, RK SINGH[2], VK DUA[3], SK SINGH[4], SARALA YADAV[2] AND RAHUL R BAKADE[2]

ARTICLE INFO

Received on : 11-06-2020
Accepted on : 14-08-2020
Published online : 01-09-2020

ABSTRACT

A field experiment was carried out during 2015-16 and 2016-17 at ICAR-Central Potato Research Station, Patna, Bihar, in randomized block design with four replications with objective to quantity the optimum requirement of nitrogen to potato crop. Significantly the highest plant height was recorded with nitrogen level of 300 kg/ha. Distributions of the smallest size of tuber yield of potato were decreasing with increasing the level of nitrogen. There was about 26.0% more yield of the smallest size tuber of potato was recorded with zero nitrogen as compare to the highest level of nitrogen i.e. 300 kg/ha. Increasing the nitrogen over the level of 150 to 225 kg per hectare, increasing the yield of tuber gradually slower rate than nitrogen level from 0 to 150 kg/ha. Total and marketable tuber yield of potato were increasing significantly with increasing level of nitrogen up to 150 kg/ha. There was no significant difference in marketable tuber yield was found for nitrogen level between 150 and 225 kg/ha. Highest (1.66) net benefit cost ratio was also recorded with level of nitrogen @ 150 kg/ha in potato. Hence, application of nitrogen @ 150 kg/ha was found statistically and economically more beneficial for potato cultivation in Eastern Indo-Gangeatic plain of India.

KEYWORDS

Fertilizer, Nitrogen, Nutrient, Potato, Tuber

INTRODUCTION

Potato (*Solanum tuberosum* L.) is considered as one of the fourth most important widely grown tuber crop in the world after rice, wheat and maize (Singh *et al.*, 2015). Presently India is the second largest producer of potato after China in the world. Cultivation of potato has been become very popular among the growers besides high demand and more yield potentials as compare to other crops in this region. Shorter duration of crop has become more advantageous to adjust in different crop rotations under most of the existing cropping systems. Nitrogen is one of the most limiting nutrients among the major nutrients of potato for Eastern Indo-Gangatic plain region of India (Yadav *et al.*, 2020). Nitrogen plays important role in productivity of potato as being its main component for the synthesis of nucleic acids, proteins, chlorophyll etc. (Najm *et al.*, 2012). Besides its major role in potato, nitrogen is also one of the most commonly used fertilizers in potato to increase the productivity due to easily availability with cheaper price in the country. Excessive uses of nitrogenous fertilizers in potato may prolong the vegetative growth phase which delayed the process of tuberization followed by tuber bulking, resulting in decreasing of tuber yield with increasing cost of cultivation. Lower doses of nitrogen may also initiate premature senescence in plants resulting in poor yield due to shorter bulking duration of crop. Higher cost of cultivation of excessive use of nitrogenous fertilizers is also jeopardizing the profitability of growers (Kushwah and Singh, 2011). Besides unutilized nitrogen from the root zone of potato resulting in nitrate contaminating of ground water which is becoming a serious environmental issue (Zebarth *et al.*, 2004). Hence, the judicious requirement of nitrogen becomes essential to overcome the problem of suboptimal doses of nitrogen for increasing productivity and profitability of potato cultivation without environmental issues. Keeping above view in mind a field experiment was conducted to find out optimum nitrogen requirement for newly released potato cultivar in the Eastern Indo-Gangetic plain region of India.

MATERIALS AND METHODS

A field experiment was carried out during two consecutive years of 2015-16 and 2016-17 at ICAR-Central Potato Research station, Patna, Bihar in India. The trial was executed under All India Coordinated Research Project on potato. The soil texture of experimental field was found sandy loam having medium in availability of nitrogen in soil. The experiment was laid out with five treatments in randomized block design having four replications. The different levels of nitrogen were taken as treatment for study *viz.*, N_0 (0 kg N/ha); N_1 (75 kg N/ha); N_2 (150 kg N/ha); N_3 (225 kg N/ha) and N_4 (300 kg N/ha). Potato cultivar *Kufri Surya* is a newly released potato variety, taken under this experiment. Potato was planted during month of November in the net plot size of 3x3.6 meters with spacing of 60x20 cm. The recommended doses of fertilizers as N, P_2O_5 and K_2O were taken as 150, 60 and 80 kg/ha, respectively for potato under this region. The synthetic sources of nitrogen, phosphorus and potassium were taken in the form of urea, single super phosphate and muriate of potash, respectively. Entire dose of phosphate and potash were applied at planting of the crop in each treatment while nitrogen was applied into two splits of fixed level as per treatment in same plot. Half dose of nitrogen level was applied as basal along with phosphorus and potassium while remaining half of

[1]*ICAR-Indian Institute of Sugarcane Research, Lucknow, Uttar Pradesh, India
[2]ICAR-Central Potato Research Station, Patna, Bihar, India
[3]ICAR-Central Potato Research Institute, Shimla, Himachal Pradesh, India
[4]ICAR-Indian Institute of Vegetable Research, Varanasi, Uttar Pradesh, India
*Corresponding author email : sanjaybhu05@rediffmail.com

nitrogen was applied in same plot as per level of nitrogen at the time of earthing up.

Standard package and practices for weed, disease and insect management for potato crop were followed as per recommendation of the crop for this region. Simultaneously weeding and earthing up was done between 25-30 days after planting in each year to cover around the plants with loose soils mass for intact development of tubers at the stolen tips. Two spraying of Mancozeb and one spraying of Curzate (cymoxanil 8% + mancozeb 64%) were done at different intervals for controlling the devastating disease of potato i.e. late blight. Spraying of fungicides was done as a preventative measure just before appearing of disease in the field according to the forecast of appearance of disease. Insect pest were managed as per their incidence by applying recommended insecticide (*Imidacloprid* or *chlorpyrifos*) for potato in this region to maintain the insect population below the economic threshold level.

Plants samples were selected randomly in each plot to determine height and number of shoots at the maximum growth stages of crop. Three plants from each treatment were harvested from the earmarked area outside the net plot and brought to the laboratory for analysis. The selected samples were separated into tubers, green leaves and haulms and their dry weights were recorded after drying in a hot air oven at 75^{0}C till constant weights were obtained. Potato biomass above ground (haulm) were removed at maturity followed by manual harvesting of each plot were completed. All the harvested tubers were mild dried in shade and graded with their weight as large (>75 g), medium (50-75 g), small (25-50 g) and very small (< 25 g). The tuber yield of potato of different plots as per treatment were estimated and converted into tonnes per hectare. All observations for each observation were subjected to analyze statistically according to the standard method. The calculated values of the treatment and error variance ratio were compared with Fisher and Yates F table at 5% level of significance. The differences between significant treatments means were tested against C.D. at 5 percent of probability.

RESULTS AND DISCUSSION

Growth attributes

The data presented in Table 1 revealed that no significant difference in plant emergence was found due to different level of nitrogen under the both the year of investigation. The range of emergence of potato tuber was recorded from 94.3 to 98.0% during the both the years. Plant height of potato was found significantly superior with various nitrogen levels over zero level of nitrogen during both the years of observations. Highest plant height was noticed with application of nitrogen @ 300 kg/ha (Fig.1). However, there was no significant variation was recorded among different nitrogen doses from the lowest to maximum. Nitrogen is one of the most important nutrients essential to growth and development of potato. Higher doses of nitrogen enhance the plant height due to playing crucial role for formation of essential amino acid and chlorophyll content of plant which accelerates the vegetative growth of plant (Jatav *et al.,* 2017). Overall number of shoots per plant was noticed slightly higher through application of nitrogen as compare to without nitrogen. There was no significant variation among the numbers of shoots per plant was recorded with different levels of nitrogen. Similar result was also reported by (Lynch and Rowberry, 1997). This was might be due to that genetic makeup of variety to initiate number of shoot per seed tuber may be another factor play important role in potato.

Table 1: Effect of nitrogen levels on growth attributes of potato

N level (kg/ha)	Emergence (%)		Plant height (cm)		Shoots/plant (No.)	
	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17
0	96.25	96.5	27.2	26.5	3.85	3.62
75	98.00	96.0	32.0	33.3	3.90	4.01
150	97.75	95.3	33.2	33.3	3.45	3.73
225	96.75	95.5	34.2	34.8	3.90	3.92
300	97.25	94.3	35.9	35.8	3.60	3.71
SE±	0.51	1.2	1.5	1.7	0.54	0.48
CD(0.05)	NS	NS	3.6	3.8	NS	NS

Fig. 1: Field view of experimental plot potato at CPRS Patna

Table 2: Effect of nitrogen levels on yield (t/ha) of potato tuber grades

N level (kg/ha)	0-25g		25-50g		50-75g		>75g	
	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17	2015-16	2016-17
0	1.25	3.51	4.95	3.01	4.28	5.22	4.41	5.10
75	1.47	2.92	5.06	4.20	7.13	8.10	10.34	7.91
150	1.44	2.80	6.48	5.02	9.53	10.71	12.41	8.90
225	0.94	2.20	3.63	5.23	8.29	12.21	14.28	11.1
300	0.98	2.83	3.82	5.31	8.44	10.90	12.78	9.90
SE±	0.31	0.31	1.45	0.50	0.97	0.70	0.96	0.70
CD(0.05)	NS	Ns	NS	1.10	2.14	1.61	2.11	1.51

Distribution of tuber grades

The detail of tuber grades of potato has been depicted in Table 2 shown that the distributions of smallest size of tuber yield were decreasing with increasing the level of nitrogen in potato. There was about 27.6 and 25.0% more tuber yield of smallest size of potato was recorded as first year and second year, respectively with zero level of nitrogen over the highest level of nitrogen (300 kg/ha). However, the medium to large size tuber yield of potato were increasing significantly with increasing the level of nitrogen from 0 to 150 during both the years. Highest level of nitrogen was recorded significantly lower tuber yield of smallest size tuber than 150 and 225 kg/ha as first year and second year, respectively. Increasing the nitrogen over the 150 to 225 kg per ha increasing the yield of tuber was recorded gradually slower rate as compare to 0 to 150 kg N/ha. Generally, numbers of potato tubers per plant become smaller in size with poor nitrogen availability as compare to higher level of nitrogen. This was might be due to that lower dose of nitrogen causes early crop senescence in potato (Kleinkopf *et al*., 1981) which reduced the bulking rate in tuber, resulted in poor partitioning of food material (Westermann and Kleinkopf, 1985). However, excessive available nitrogen to plant can result in delayed tuberization, consequently reduced yields of potato.

Tuber yield

Total and marketable tuber yield of potato has been depicted in Table 3 revealed that the yield of potato tuber was increasing with increasing level of nitrogen up to 150 kg /ha during 2015-16 and up to 225 kg during 2016-17. However, there was no significant variation in yield of potato was recorded due to increasing the level of nitrogen over 150 kg/ha during 2016-17. Similar response over two years for total tuber yield was also recorded on mean basis. Similarly, there was no significant difference in marketable tuber yield was found between 150 and 225 kg/ha of nitrogen levels. However, mean marketable yield was recorded the maximum with nitrogen level of 225 kg/ha in potato. Relationship between nitrogen level and tuber yield has been also shown by the Fig.2 that tuber yield of potato was increasing up to certain point and thereafter it gradually decreasing due to increasing the level of nitrogen. Reduction in marketable yield was also noticed due to increasing the nitrogen level beyond the 225 kg/ha. Higher doses of nitrogen stimulated the more vegetative growth of potato which delayed the tuberization process; consequently, majority of energy used to maintain the foliage growth besides translocation of the food material to the sink resulted in reduction of marketable tuber yield (Zareabyaneh and Bayatvarkeshi, 2015). Plant also remains in vegetative stage for longer duration and delayed in maturity due to higher availability of nitrogen in soil. Lauer (1986) also reported that excessive available N can result in delayed tuberization, consequently reduced yields of potato.

Table 3: Effect of different nitrogen levels on economic tuber yield of potato

N level (kg/ha)	Total tuber yield (t/ha)			Marketable tuber yield(t/ha)		
	2015-16	2016-17	Mean	2015-16	2016-17	Mean
0	14.9	16.7	15.8	13.6	13.3	13.5
75	24.0	23.1	23.6	22.5	20.2	21.4
150	29.9	27.3	28.6	28.4	24.6	26.5
225	27.1	30.6	28.9	26.2	28.3	27.3
300	26.0	28.9	27.5	25.0	26.1	25.6
SE±	1.5	1.7	1.6	1.2	1.4	1.3
CD(0.05)	3.4	3.8	3.6	3.7	3.9	3.8

Regression analysis between nitrogen level and tuber yield of potato has been also shown in Fig. 2 revealed that initial yield of potato is increasing with increasing of nitrogen level and reached the maximum between 150 to 225 kg of nitrogen per hectare. There will be no enhancement in tuber yield beyond increasing the level of nitrogen over 225 kg per ha. Both higher and lower doses of nitrogen over optimum doses have negative impact on productivity of potato (Dubey *et al*., 2012). However, there was no

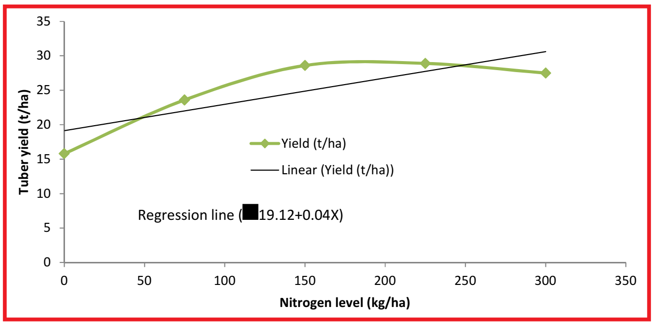

Fig. 2 Relationship between nitrogen levels (kg/ha) and potato tuber yield (t/ha)

significant variation in tuber yield was recorded between 150 to 225 kg of nitrogen. Jatav *et al.* (2013) also reported the similar yield reduction in potato due to sub optimum doses of nitrogen in potato. Regression line and curve revealed that it is better to give the nitrogen to potato between 150 to 200 kg/ha for getting the maximum economic tuber yield of potato.

Economics

Economics of potato cultivation due to different nitrogen level have been given in Table 4 revealed that nitrogen level @ 225 kg /ha recorded the highest net return. However, the net benefit cost ratio was found the highest due to nitrogen level @150 kg /ha. The cost of cultivation is also increasing with increasing the level of nitrogen over 150 kg /ha, consequently decreasing net benefit cost ratio of potato cultivation. Slight increase (3%) in net return was recorded with increasing nitrogen level from 150 kg to 225 kg/ha. However, for same level of nitrogen i.e. 225 kg/ha, recorded reduction in net benefit cost ratio about 2%. Hence, application of nitrogen @150 kg/ha was found economically more beneficial for potato cultivation.

Table 4: Economics of different nitrogen level in potato ($\times 10^3$ Rs/ha) (Mean)

N level (kg/ha)	Seed cost	Fertilizers cost	Cultivation cost	Total cost	Net return	B:C ratio
0	45.0	7.40	31.0	83.4	43.8	0.53
75	45.0	8.60	31.2	84.8	104.0	1.23
150	45.0	9.80	31.2	86.0	142.8	1.66
225	45.0	11.0	31.2	87.2	144.0	1.65
300	45.0	12.2	31.2	88.4	131.6	1.49

CONCLUSION

Based on the statistical significance and economic feasibility of result it may be concluded that nitrogen requirement of potato under irrigated ecosystem may be recommended @ 150 kg/ha for optimum productivity of potato under Eastern Indo-Gangetic plain region of India.

REFERENCES

Dubey RK, Singh V, Devi K, and Kartek K. 2012. Effect of nitrogen levels and cultivars on growth and yield components of potato in foothills of Arunachal Pradesh. *Indian Journal of Horticulture* **69**(4): 545–549.

Jatav AS, Kushwah SS and Naruka IS. 2017. Performance of Potato varieties for growth, yield, quality and economics under different levels of nitrogen. *Advances in Research* **9**(6): 1-9.

Jatav MK, Kumar Manoj, Trehan SP, Dua VK and Kumar Sushil. 2013. Effect of nitrogen and varieties of potato on yield and agronomic use efficiency in north-western plains of India. *Potato Journal* **40**(1): 55-59.

Kleinkopf GE, Westermann DT and Dwelle RB.1981. Dry matter production and nitrogen utilization by six potato cultivars. *Agronomy Journal* **73:** 799-802.

Kushwah VS and Singh SP. 2011. Relative performance of low input and high input technology for potato production in India. *Potato Journal* **38**(1): 56-60.

Lauer DA. 1986. Russet Burbank yield response to sprinkler-applied nitrogen fertilizer. *American Potato Journal* **63**: 61-69.

Lynch DR and Rowberry RG. 1997. The effect of fertilization and plant density on growth, development, and yield. *American Potato Journal* **54**: 57-71.

Njam AA, Haj Sayed Hadi, Fazeli MR, Darzi MT and Rahi A. 2012. Effect of integrated management of nitrogen fertilizer and cattle manure on the leaf chlorophyll, yield and tuber *glycoalkaloids* of Agria Potato. *Communications in Soil Science and Plant Analysis* **43**(6):912-23.

Singh SK, Lal SS, Dua VK and Singh RK. 2015. Nitrogen management in maize + potato inter cropping system under eastern Indo Gangetic Plains of Bihar. *Journal of AgriSearch* **2**(4): 244-50.

Westermann DT and Kleinkopf GE. 1985. Nitrogen requirements of potatoes. *Agronomy Journal* **77**: 616-621.

Yadav SK, Singh RK, Singh SK, Yadav S and Bakade RR. 2020. Site specific nutrient management in potato through nutrient omission plot technique. *Journal of AgriSearch* **7**(2):59-62.

Zareabyaneh H and Bayatvarkeshi M. 2015. Effects of slow-release fertilizers on nitrate leaching, its distribution in soil profile, N-use efficiency, and yield in potato crop. *Environmental Earth Sciences* **74:** 3385-3393.

Zebarth BJ, Tai G, Tarn R, de Jong H and Milburn PH. 2004. Nitrogen use efficiency characteristics of commercial potato cultivars. *Canadian Journal of Plant Science* **84**: 589–598.

Citation:
Yadav SK, Singh RK, Dua VK, Singh SK, Yadav S and Bakade RR. 2020. Nitrogen requirement of potato for Eastern Indo-Gangetic Plain of India. *Journal of AgriSearch* **7**(3):134-137