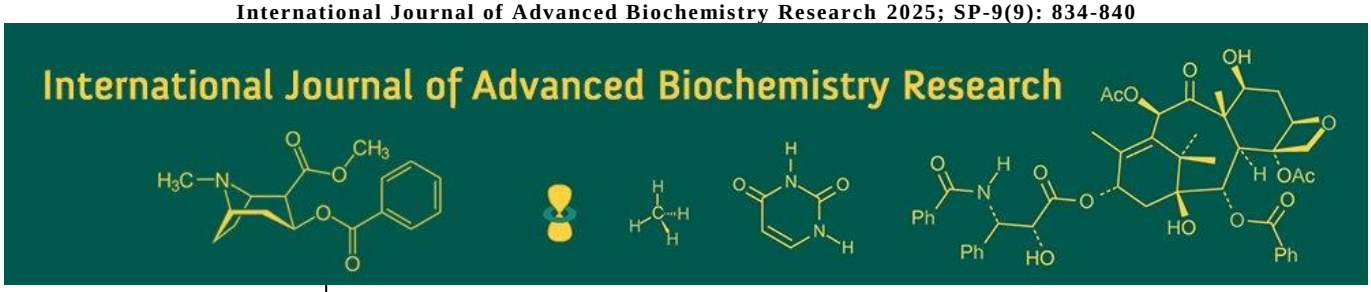

ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2025): 5.29
IJABR 2025; SP-9(9): 834-840
www.biochemjournal.com
Received: 18-06-2025
Accepted: 21-07-2025

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Evaluation of balanced use of fertilizers in tomato and its nutritive value for human health: An effective strategy for doubling of farmers' income in Maharashtra state, India

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DOI: https://www.doi.org/10.33545/26174693.2025.v9.i9Sk.5604

Abstract
The study was conducted in two districts Nasik and Sholapur of Maharashtra state during the two different agricultural year 2012-13 (base year) and 2014-15 (assessment year). A total of 56 farmers, from the district have been selected for detailed survey. Tomato is the major vegetable crop and playing critical role in the agrarian economy of the state. The vegetable crops are highly fertilizers consuming so that impact assessment of balanced fertilizer (NPK) use can be worked out. Primary data of input use especially inorganic fertilizer and their impact on yield and production of tomato were collected by interviewing the beneficiary farmers with the help of well-developed and pre-tested socioeconomic survey schedule. The extent of incremental income derived from the tomato production in surveyed area in assessment year has been emerged as impact of balanced use of inorganic fertilizer in enhancing profitability of crops as well as income of farmers. The quantity of NPK fertilizers were applied by the farmers 129, 75 and 26 kg/ha on surveyed farms of selected districts in base year which is lower when compared to recommended doses of application in assessment year. However, the application of NPK doses were about 86, 65 and 60 kg/ha in the district during assessment year. The incremental income of Rs. 58581/- per hectare was realized from tomato cultivation in the assessment year. Farmers also perceived that quality of fruit improved and quantity of produce increased as well after balanced use of NPK. The farmers' practices include reducing the doses of nitrogen and induced quantity of potassium fertilizers is the key factor for enhanced income. However, it was also observed that the use of balanced fertilizer the incidences of disease and pest infestation reduced as reported by more than 86% farmers in the surveyed area. Therefore, appropriate technological interventions and policy option need to be design to encourage farmers for use of balanced inorganic fertilizers especially potassic in vegetable crop production.

Keywords: Tomato, nutrient, incremental income, productivity

Introduction
Agriculture is the vital source of livelihood and income generation of farming community in the Maharashtra State with about 68% of its population the contribution of food grain, fruit, vegetables, spices and flowers production along with management practices strengthened economy of farming community. The various crops were included in cropping pattern especially bajra and maize are important cereal crops whereas among the vegetables tomato and onion are predominating crops cultivated in the state. Grapes are most important fruit crop grown in the Nasik district.

Nasik district comprises of many blocks but socioeconomic survey was conducted in two blocks: Sinnar and Niphad, where 'Potash for Life' project activities are going on rigorously to assess the impact of potash use in the productivity of different crops. In Sinnar block, Manegaon and Lonarwadi villages were selected and collected data related to cultivation practices of tomato. In block Niphad, Malasakore villages have been selected where a total of 56 respondents were interviewed. They also shared their experiences of by applying/using potash in the crops and orchard being grown.

The objective of this paper is to characterize the production practices of tomato cultivation and evaluation the impact of applying/using potash with nitrogenous and phosphatic

fertilizers in production practices and their influence on profitability by enhancing production and reduction of costs in tomato in the state.

Survey design and data collection

The present study has been carried out on the basis of primary data collected from two different districts namely; Nasik and Sholapur for two different agricultural years 2012-13 considered as bench mark or base year and 2014-15 as assessment year on which evaluation can be made of balanced use of NPK fertilizers in tomato cropping system especially application of potash. From each district, 28 farmers have been selected so that a total sample of 56 farmers have been surveyed from six experimental villages of both districts The name of villages are Manegaon, Lonarwadi and Mlsakore from Nasik district and Tapkirishetphal, Shirvari and Haldalwari from Sholapur. Required data from sample farmers were collected through a pre-tested socioeconomic survey schedule by personal interview method. Descriptive statistical analysis were used to compute average, mean etc. Tabular analysis has been used to obtain the results of the cropping pattern, physical input use, labor use in man days and cost of and returns analysis of tomato cultivation in target area.

Nutritional value of tomato is also studied from available sources of publication. Among the vegetables, tomato is highly demanding due to its various medicinal and protective quality of human health aside taste of consumer. The price of tomato in the market is highly variable and fluctuation (volatility) in nature but consumer demand is always being slightly elastic. There is a particular segment of society who cannot take meals without tomato in its either preparation. Tomato has several preparations as sole, mix with other vegetables, pulses, meat, fish, egg, chutney etc.

Results and Discussion

Table 1 presents the detailed description of selected villages of Nasik and Sholapur districts. The three villages have been selected from each selected district. The total samples sizes of respondent-farmers were 56 for detailed study of tomato cultivation practices. The average farming experience of farmers was 24 years while the average age is 42 years. The average schooling years of household head was 11 years and farming experiences were 24 years. The average cultivated areas of farmer-beneficiaries were 2.20 and 4.50 ha in Nasik and Sholapur district, respectively. On an average 66% farmers were derived their income from farming occupation in surveyed area and farming is their only occupation. Whereas about 13 and 15% household engaged in Government and private services. Infrastructure and utility services facility like input market, availability of electricity, connectivity road, drinking water, hospital and school etc. were available in all the selected villages in both the districts.

Table 1: Description of surveyed villages by districts.

Particulars/descriptions	Nasik	Sholapur	Numerals
Name of villages	Manegaon, Lonarwadi and Mlsakore	Tapkirishetphal, Shirvari and Haldalwari	-
Number of farmers	28	28	56
Average age of households head (years)	41	44	42
Average schooling of household head (years)	12	10	11
Experience in farming (years)	21	27	24
Average family size (no.)	5	6	5
Average cultivated area/household (ha.)	2.2	4.5	3.3
Average area under tomato/household (ha.)	0.07	-	0.07
Occupation (%)			%
Farming	68	64	66
Government services	14	11	12.5
Private services	11	18	14.5
Infrastructure (%)			
Access to input market	100	100	100
Access to electricity	100	100	100
Pucca road (connected sub-road)	100	100	100
Drinking water supply	100	100	100
Access to school/colleges	100	100	100
Land type (%)			
Upland	26.3	7.2	16.75
Midland	73.7	92.8	83.25
Irrigated area (%)	100	100	100
Area under tomato (ha)	0.07	-	0.07

Cropping pattern on sample farm

Tomato is being cultivated in kharif (rainy) and rabi (winter) season in surveyed area. The kharif season tomato crop is less profitable due to various production constraints such as erratic rainfall, disease and insects than the rabi season. Tomato covers an area of about 11% to total cropped area in kharif and rabi both the season during 2012-13 and 2014-15 years. Besides above, other crops *viz*, soybean, grapes, cabbage cauliflower, carrot, sugarcane, groundnut, okra etc. are also being cultivated and acreage ranged from 0.6 to 25% on overall basis. Likewise, in rabi season grapes, cabbage, tomato and soybean were cultivated and covers an area of 0.6-24% and 2-24% in both the study periods.

In Solapur, pomegranate is mainly cultivated in about 27% area in both the seasons across the study periods. In addition to it, other crops *viz*, wheat (9%), gram (10-11%), maize

(12-13%), perlmillet (2%), sugarcane (2- 3%) and sorghum (8%) are also being cultivated in rabi season by the selected farmers. No crop is cultivated in zaid season (summer) due to water scarcity and stray animal's problems. Productivity of different crops was also taken into consideration to assess impact of application of potassic fertilizer on production potential of different crops and it can be vaguely seen from the table that productivity of other crops is also enhanced in assessment year than the base year.

Table 2: Cropping pattern on sample farms

Particulars/Districts/ Years	Nasik				Sholapur			
	2012-13		2014-15		2012-13		2014-15	
	Area ha	%	Area ha	%	Area ha	%	Area ha	%
Kharif season								
Soybean	16	25	16	26	-	-	-	-
Maize	12	20	11	18	26	21	26	21
Onion	9	15	9	15	-	-	-	-
Grapes	7	12	7	12	-	14	-	13
Tomato	7	11	7	11	-	-	-	-
Cabbage	5	8	5	8	-	-	-	-
Cauliflower	3	4	3	4	-	-	-	-
Carrot	0.7	1	0.7	1	-	-	-	-
Fallow	0.7	1	0.7	1	25	20	25	20
Sugarcane	0.7	1	0.7	1	5	4	5	4
Groundnut	0.5	0.9	0.5	0.9	-	-	-	-
Okra	0.4	0.6	0.4	0.6	-	-	-	-
Pomegranate	-	-	-	-	51	40	51	40
Jowar	-	-	-	-	14	11	13	10
Gram	-	-	-	-	0.4	0.3	-	-
Pearl millet	-	-	-	-	4	3	5	4
Green fodder	-	-	0.7	1	2	1	2	2
Kharif Total	62	100	62	100	126	100	126	100
Rabi								
Pomegranate	-	-	-	-	51	40	50	39
Wheat	15	24	15	24	1	1	1	0.9
Onion	12	19	12	19	-	-	-	-
Gram	11	17	10	16	9	7	9	7
Maize	6	9	6	10	17	14	18	14
Grapes	5	8	3	5	-	-	-	-
Cabbage	3	4	2	4	-	-	-	-
Tomato	2	4	3	4	-	-	-	-
Soybean	2	3	3	4	-	-	-	-
Cauliflower	0.7	1	2	4	-	-	-	-
Pearl millet	-	-	-	-	4	3	4	3
Fallow	6	9	6	9	26	20	26	20
Sugarcane	0.7	1	1	2	4	3	4	3
Sorghum	-	-	-	-	15	12	15	12
Green fodder	0.4	0.6	-	-	-	-	-	-
Rabi Total	62	100	62	100	126	100	126	100

Input used in tomato cultivation.

Tomato is the important crop of the study area which provides better economic returns for strengthen livelihood security of farm families and shaping economic structure. Though input use was higher in initial stages but income has also been higher in same proportions (Table 3 & 4). As the tomato production and quality depends upon nutrient availability in the soil and extent of balanced fertilizer application according to requirement. The nitrogen in adequate quantity applied to increases fruit quality, size, color and taste, addition to vegetative growth. It also helps in increasing desirable quality. Adequate amount of potassium is also required for growth, yield and quality.

Recommended doses of N:P:K in tomato crop is 100 kg nitrogen 60 kg phosphorous and 60 kg potash per hectare is to be used in entire crop season. The recommended ratio of N:P:K is 1.66:1:1 (220kg nutrient). Half dose of nitrogen and full doses of phosphorous and potash is to be incorporated at the time of land preparation and remaining dose of nitrogen is to be applied after 20-25 days of planting. In base year the average doses of N:P:K nutrients were applied in the ratio of 4.96:2.88:1 (230 kg), which is far deviating than recommended doses as nitrogen and phosphorous is being applied in higher amount and potash is relatively lesser doses than recommended. This data shows that nutrient application was quite injudicious before inception of PFL project activity in selected farm houses. However, after rigorous demonstrations of potassic nutrient management the cooperator farmers started to apply N:P:K nutrients in recommended doses and ratio obtained in assessment year to be 1.43:1.08:1 (211 kg) this shows that the farmers have applied appropriate amount of nutrients in later years this may be outcome of PFL demonstration activity on farmers field. (Table-3).

Table 3: Input used in tomato cultivation on sample farms.

Particulars	Units	2012-13	2014-15	% change
Yield	qtls/ha	234	308	24
Material cost				
Area	ha	5.0	5.0	-
Seed	g/ha	309.4	285.3	-7.8
N	kg/ha	129.0	86.0	-33.3
P	kg/ha	75.0	65.0	-13.3
K	kg/ha	26.0	60.0	130.8
Total NPK	kg/ha	230.0	211.0	-8.2
Herbicide	Lit/ha	2.7	2.1	-23.6
Insecticide	Lit/ha	2.7	2.2	-20.4
Labor use				
Area	ha	5.0	5.0	-
Land Preparation	Mandays/ha	8	9	11.1
FYM application	Mandays/ha	7	6	-16.7
Planting of seedling/nursery	Mandays/ha	13	19	31.6
Fertilizer application	Mandays/ha	7	9	22.2
Intercultural operations& earthing up tomato plants	Mandays/ha	14	14	0.0
Herbicide application	Mandays/ha	3	2	-50.0
Irrigation	Mandays/ha	7	7	0.0
Pesticide application	Mandays/ha	5	6	16.7
Picking tomato	Mandays/ha	44	47	6.4
Grading	Mandays/ha	18	15	-20.0
Transportation	Mandays/ha	5	5	0.0
Total	Mandays/ha	131	139	5.8

Sources of NPK nutrients- Urea, DAP and MOP, Data source: Farm survey, 2014-15

In case of tomato, more labor used in picking tomato, grading, planting of nursery, soiling tomato plants/earthing up and weeding operation, while in case of crop management labor used were similar for all operations in both the years. Since tomato picked in several stages, therefore, huge labors are required for this operation. In total there were 5.8% more labours used (139) in 2014-15 than 2012-13 (131) which are proxy of yield enhancement of tomato crop on farmer's field in target area.

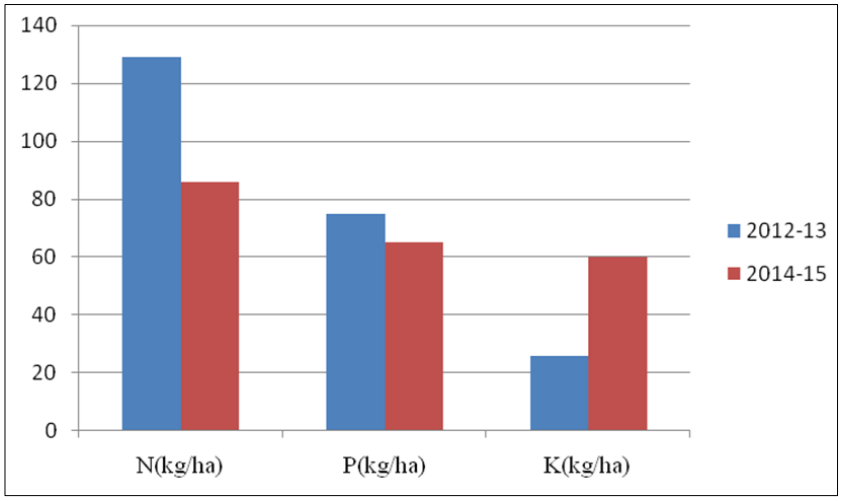

Fig 1: NPK used in tomato cultivation (kg/ha)

Cost and returns analysis of tomato cultivation

Tomato is cultivated mainly as a cash crop and major source of livelihood in surveyed area. It is a short duration vegetable crop so the income can be generated within a period of 3 to 6 months which are quite helpful for farm families to meet out various types of house core expenses. Tomato cultivation is being undertaken by farmers as a commercial crop which strengthened economy of farmers. Tomato cultivators were usually purchase HYVs seed from the market and prepare plants by establishing nursery on their own field. The cost incurred on different items are includes the cost of seeds, land preparation, fertilizers, planting, insecticide, irrigation labor charges, crop care etc. Material cost primarily includes cost of seed, fertilizers, plant protection chemicals etc. and it accounted 47% to total cost in assessment year which is decreased by 13% than base year. A substantial proportion of fertilizers cost reduction was made in urea, DAP, herbicide and insecticide as they tend to reduce by 23, 27, 13 and 15%, respectively, in assessment year. However, cost of potassic fertilizers increased by 159% as farmers are using recommended doses in assessment year. Cost involved in machine operations ranges 7% of total cost of cultivation across the years. The total average cost of cultivation of tomato crop came out to

be Rs. 40504/- and 49414/- per hectare in base and assessment year respectively, which is an increase of 22% in the assessment year. In spite of higher cost of cultivation in assessment year, net return tend to be increased by 21%, this may be result of using judicious amount of nutrients and higher doses of potassium by selected households.

Table 4: Cost and returns analysis of tomato cultivation. (Rs./ha)

Particulars	Tomato	
	2012-13	2014-15
1. Material cost	24252.00 (60)	23214.00 (47)
2. Labor cost	13590.00 (33)	22748.00 (46)
3. Machine charges	2661.00 (7)	3454.00 (7)
Total cost	40504.00 (100)	49414.00 (100)
Analysis of yield & returns		
Yield (qtl./ha)	234	308
Average disposal rate of produce (Rs./qtl)	585.00	635.00
Gross value of produce (Rs.)	1,36,927.00	1,95,508.00
Net Returns (Gross value-total cost) Rs.	96,423.00	1,46,093.00
Incremental income (Rs./ha)	-	58581.00
Cost (Rs./qtl.)	173.00	160.00
Return on Rs./ investment	2.00	3.00

Sources of potash for life project in Nasik district of Maharashtra state.

The gross value of tomato sold in the market were Rs.1,36,927.00 and Rs. 195508.00/hectare in base and assessment years The incremental income of Rs.58581.00 /hectare were realized from tomato cultivation in the assessment year over base year. The one rupee return of expenditure was Rs.2.00 and 3.00 in base and assessment years, respectively, of tomato cultivation (Table 4).

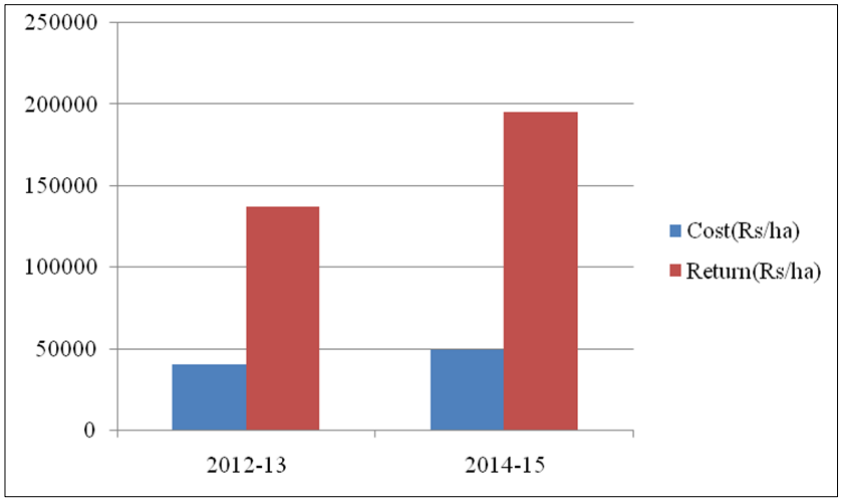

Fig 2: Cost and return of tomato crop.

Ranking of responses of farmer-beneficiaries of application of potash.

Table 5 indicates the ranking wise responses for use of potash under surveyed area. The data is showing that hoardings, radio publicity, field days and potash campaigns are considered to be most effective and strong communication tools to educate farmers for use of potash in crop cultivation.

Table 5: Ranking of responses of farmer-beneficiaries of application of potash.

Particulars	Positive responses	% age of responses	Ranks of responses
Demonstration plots	41.0	73.2	I
Field Days	33.0	58.9	II
SMS Mobile voice	30.0	53.6	III
Printed Publicity Material-Brochures	29.0	51.8	IV
Crop Seminars and Farmers Meeting	27.0	48.2	V
Wall Paintings	26.0	46.4	VI
Radio Publicity	25.0	44.6	VII
Digital Media-www.potash4life.com	24.0	42.9	VIII
TV Publicity	23.0	41.1	IX
Agri Fairs	22.0	39.3	X
Hoarding	21.0	37.5	XI
Potash Campaigns	20.0	35.7	XII
Puppet Shows	0.0	0.0	XIII

An overall basis about 73, 59, 54 and 52% farmers are used information from demonstration plots, Field Days, SMS Mobile voice and Printed Publicity Material-Brochures communication tools, respectively. Besides these, demonstration plots, wall painting, SMS mobile alerts are also important to give timely information regarding potassic fertilizer availability, doses and fertilization techniques to the farmers. TV Publicity, crop seminars and farmers conclave/gosthi, agri-fair are also emerged out as a beneficial tool of communication in experimental sites/surveyed area as many farm beneficiaries are getting necessary information from these sources.

Health benefits of consumer by eating tomatoes.

There are numerous health benefits to consumer to eating tomato in daily diet (Table 6).

Table 6: Contents of tomato.

S. No.	Contents	Per 100gm of red tomato
1.	Vit E	0.54 mg
2	Vit K	7.9 ug
3	Mg	11 mg
4	Sugar	0.2 g
5	Fat	0.9 g
6	Water	94.5 g
7	S	24 mg
8	Cl	38 mg
9	Na	5 mg
10	Vit A	833 IU
11	Vit B1 (Thiamine)	0.037 mg
12	Vit B3 (Niacin)	0.594 mg
13	Vit B6	0.08 mg
14	Vit C	14 mg
15	Energy	18 K
16	Carbohydrate	3.9g
17	Dietary fiber	1.2 g
18	Mn	0.114 mg
19	Fe	0.3 mg
20	Cu	0.19
21	K	237 mg
22	Lycopene	2527 ug
23	Oxalic acid	2 mg
24	Ca	20 mg
25	P	24 mg

Source: Nutrient data laboratory, ARS, USDA.

It has antioxidant protection quality and the vibrant red colour of tomato comes from lycopene, a powerful and strong antioxidant that protects cells from damage and reduces inflammation in the human body. Improve health of human beings by uptake of tomato in daily diet on continuous basis. Also improved vision and eye protection, addition to it has anti-cancer booster, benefits in skin care and bone protection. Due to strong demand, tomato production also enhances and strengthened livelihood and economy of farming community.

Concluding remarks

Assessing the impact of balanced use of fertilizers in tomato crop an effective strategy for doubling of farmers income in Maharashtra revealed that the tomato crop covered around 7 hectare area in base and assessment year, respectively. The doses of NPK applied by sample growers in tomato crop were 129, 75 and 26 kg/ha in base period while in case of assessment year the doses of NPK were 86, 65 and 60 kg/ha, respectively. Farmer also perceived that quality of tomato that is improved and quantity of produce increased after balanced use NPK especially reduced the doses of nitrogen and induced quantity of potassium fertilizers in the crop/field. The per hectare cost of cultivation of tomato were Rs. 40504.00 in base year and Rs. 49414.00 in assessment year under surveyed area, respectively. The gross value of produce of tomato crop was Rs. 1,36,927.00 in base year and Rs. 1,95,508.00 in assessment year. The incremental income of Rs.58581.00 per household are realized from tomato crop, respectively, in the assessment year over base year.

The above findings also indicates that eating of tomato in daily diet have several benefits for consuming family/community. Tomato has good potential to protect human health from several disorder and deficiency by available essential elements/contents in it.

The above analysis revealed that the fertilizer policy of the country should be revised and redesign and include the potassic fertilizer as an essential nutrient of crops being grown by the farmers. Availability of potash fertilizer in the market at the time of crop cultivation be ensure and also make necessary arrangement for proper distribution to the farmers in the locality.

Acknowledgement

Financial assistance offered for this study by Dead Sea Works (DSW) Israel and Indian Potash Limited, New Delhi through project entitled ‘Potash for Life’ and farmers of Maharastra are duly acknowledged.

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