KRISHI VIGYAN KENDRA, KAUSHAMBI

ICAR

Project Report

on

"PERFORMANCE OF CALCIUM METALOSATE AND MULTI-MINERAL METALOSATE FERTILIZERS ON YIELDS OF POTATO & TOMATO CROPS"

by

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Background:

M/s Indofil have developed efficient fertilizers through its R & D and hold the patent for the same. They plan to introduce some of these fertilizers in India for which registration of products is a pre-requisite in FCO. As per the guidelines stipulated by Govt. of India, multi- location experiments are to be conducted of which one such location of experiment should be KVK /ICAR institutions/University. M/s Indofil decided to organize the experiments under the supervision and expertise of KVK, Kaushambi, U.P. Following are the 2 new fertilizers provided by M/s Indofil for conduction of experiments:

1) ***Calcium Metalosate*** – A fertilizer mainly to provide Ca to crop at its critical growth stage along with micro nutrients
2) ***Multi Micronutrients Metalosate –*** A fertilizer to provide complete range of micro nutrients required by crops at its critical crop growth stage.

Product details: Since both the products are patented fertilizers, M/s Indofil have decided to retain the secrecy of its composition till such time the experiments are completed. Details shall be shared with the authorities at opportune time.

Experiment location details: KVK, Kaushambi is located 35 km away from Allahabad city in village Mahagaon. It has 45 acres of irrigated

land which include Administrative and Residential Block (in 3 acres), Research/ Technology Farm (in 5 acre), Crop Cafeteria (in 3 acres), Model Nursery & Net House unit (in 2 acre), Goat & Poultry Units (in 2 Acre), Water harvesting pond & Fishery Unit (in 5 Acre) and Seed production Farm (in 25 acres). KVK is equipped with an administrative building, Farmers Training center, Farmers hostel, Library etc. It has a competent team of 7 scientists in the discipline of Agronomy, Plant protection, Soil science, Horticulture, Animal husbandry, Agriculture Extension, Home science etc.

Mandate of Krishi Vigyan Kendra: Assessment refinement & Demonstration of technologies/products.

Activities:

- On-farm testing to identify the location specificity of agricultural technologies under various farming systems
- Organize Frontline Demonstrations to establish production potential of technologies on the farmers' fields
- Training of farmers to update their knowledge and skills in modern agricultural technologies
- Training of extension personnel to orient them in the frontier areas of technology development
- To work as resource and knowledge centre of agricultural technology for supporting initiatives of public, private and

voluntary sector for improving the agricultural economy of the district

Thus KVK is fully equipped to conduct the experiment under direct supervision of its scientists with the help of resource scientist on potato and tomato crops.

KVK has been doing extension education program since 2006-07 and enjoy excellent rapport with farmers in nearby villages. It was decided to conduct the experiments at 4 different farmer fields on potato and tomato crops.

Introduction

Vegetables are an important crop in horticultural sector, occupying an area of 9.60 mill ha during 2013-14 with total production of 170.2 mill MT and having average productivity of 17.7 MT/ha. Potato is one of the most important tuber vegetable crop in the country with total area of 2.02 mill ha with a productivity of 22.92 MT/ha. (Indian Horticulture Date Base, 2013-14). Tubers of potato are rich source of starch, proteins, vitamins, minerals and an important source of essential amino acids like lysine, methionine, cysteine, phenylalanine, tryptophan etc. It is an integral part of every vegetable culinary preparation. It is used as boiled, fried, baked, mashed, stewed, roasted and other processed products.

Tomato is one of the most important vegetable crop in the country with total area of 0.90 mill ha with a productivity of 21.09 MT/ha (Indian Horticulture Date Base, 2013-14). Fruits of tomato are rich source of vitamins, protein and minerals and also known as poor man's Apple in India. It is used as soup, salad, ketchup, puree, sauces, tomato paste, tomato juice and other products. It is good source of anti-oxidants.

Proper plant nutrition is essential for successful production of vegetable crops in open and also under protected conditions. Quality is one of the most important characters in the vegetable industry and this is influenced by application of nutrients. To reach out the competitive export and domestic markets, quality plays a vital role. Integrated supply of micronutrients with macronutrient in adequate amount and suitable proportions is one of the most important factors that manipulate the plant growth and development of vegetable crops. Micronutrients are involved in all metabolic and cellular functions. Micronutrients are as important as the primary and secondary nutrient in plant nutrition.

Keeping the above points in view the present experiment is under taken to evaluate the performance of calcium metalosate and multi -mineral metalosate on yield & yield attribute parameters of potato and tomato crops.

Methodology

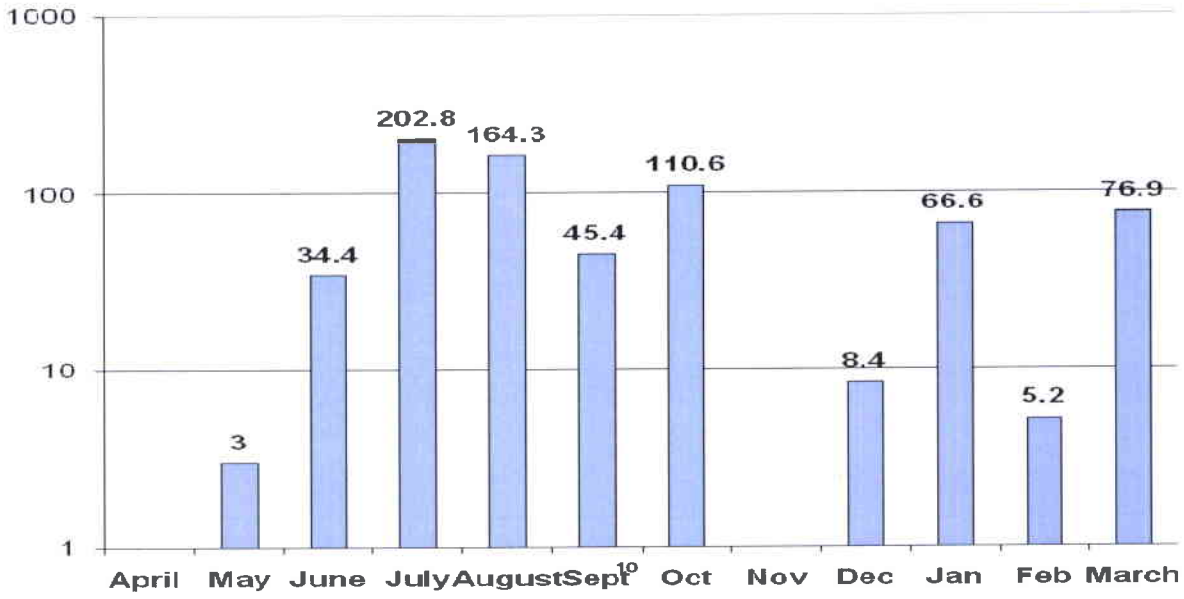
The experiment is conducted during the rabi season 2014-15. A brief description of site experiment, soil properties, climatic conditions of the area is provided. The design of experiment adopted and planting materials are dealt herewith.

Experimental Site: The experiments have been conducted at two locations i.e. KVK location and Farmer location. All the facilities necessary for cultivation including labour are readily available at both the locations.

Climate and Weather:

District Kaushambi is situated between the river Ganga and Yamuna at an elevation of 78 meter above from sea level at 25.87 N. altitude and 81.15oF longitude. This region has a subtropical climate prevailing in the south east part of U.P with both the extremes in temperature, i.e. winter and the summer. The average rain fall around 981 mm, with maximum concentration during July to September. The details of climate during the experimental year 2014-15 is given in chart below:

2014-15 (Rainfall in mm)



Temperature	Max (mean) 0C	Min (mean)0C
Jan- March	26.8	13.8
April- June	41.4	25.3
July – September	35.8	27.2
October – December	29.8	17.5

Soil: The mechanical and chemical analysis of soil done before the start of the experiment to ascertain the fertility level. Soil samples from experimental field has been analyzed mechanically and chemically. Results of the analysis is given below:

Mechanical Analysis : The mechanical analysis was done by bouyoucos hydrometer method as described by weight (1927). The results of the analysis are:

Table 1(A) Mechanical composition of soil

Ingredients	KVK Location	Farmer Location
Sand	60	60.5
Silt	26	25.5
Clay	14	14
Texture class	Sandy Loam	Sandy Loam

It is evident from the results that there are no variation in composition of soil in experimental field at KVK and farmer fields.

Chemical Analysis: The chemical analysis is done for organic carbon, nitrogen, phosphorus, potash, copper, Iron, Manganese, and Zinc. The result of the analysis are presented in the following table:

Table 1(B) Chemical composition of soil

Ingredients	KVK Location	Farmer Location	Status
Available Nitrogen (kg)	107.9	108.20	Low
Available phosphorus (kg)	15	16	Medium
Available Potash (kg)	110	112	Low
Available Copper (ppm)	.35	.36	Sufficient
Available Iron (ppm)	6.80	6.70	Sufficient
Available Manganese (ppm)	5.70	5.50	Sufficient
Available Zinc (ppm)	1.40	1.60	Sufficient

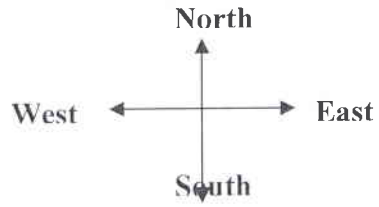
DESIGN AND TREATMENTS:

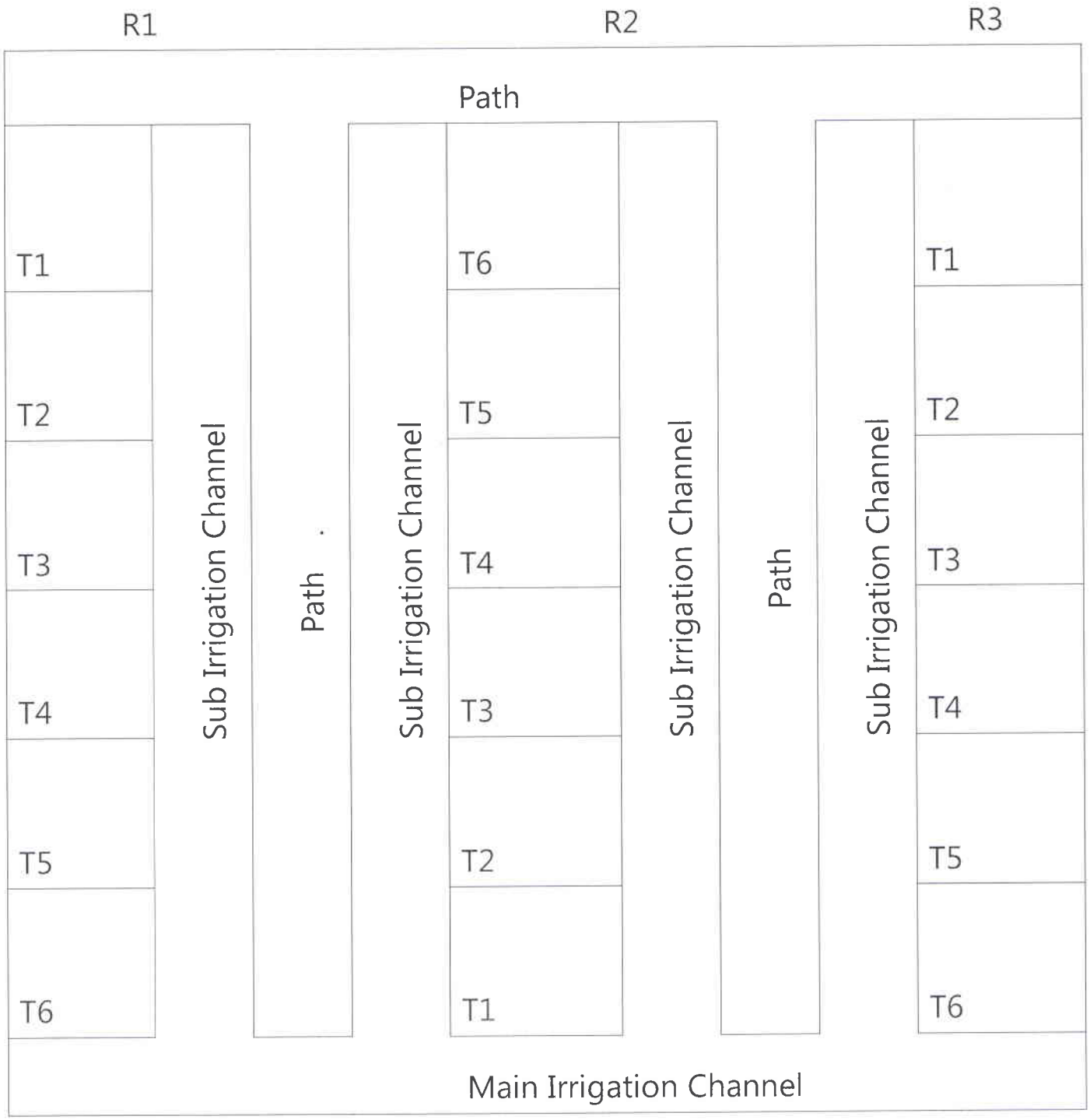
The experiment is conducted in randomized block design (RBD) with 3 levels of calcium metasolate, multi-mineral metalosate and one level of amino acid and chelated mineral with control. The total no. of treatments including control is 6. The treatments are replicated 3 times. Treatments are randomly arranged in each replication dividing into six plots. The particulars of the treatments are given as under:

Table -2

Treatments	Calcium metalosate	Multi-mineral Metalosate
T1	Calcium Metalosate @ 1ml/lt of water Rationale: Low dose	Multi mineral metalosate @ 1ml/lt of water Rationale : Low dose
T2	Calcium Metalosate @ 2ml/lt of water Rationale: Medium dose	Multi mineral metalosate @ 2ml/lt of water Rationale: Medium dose
T3	Calcium Metalosate @ 3ml/lt of water Rationale: Right dose	Multi mineral metalosate @ 3ml/lt of water Rationale: Right dose
T4	Amino Acid @ 2ml/lt of water Rationale: Competing product	Amino Acid @ 2ml/lt of water Rationale: Competing product
T5	Chelated mineral @ 1g/lt of water Rationale: Competing product	Chelated mineral @ 1g/lt of water Rationale: Competing product
T6	Control – Farmers Practice	Control – Farmers practice

LAY OUT PLAN


North
West
East
South


R1
R2
R3
Path
T1
T2
T3
T4
T5
T6
Sub Irrigation Channel
Path
Sub Irrigation Channel
T6
T5
T4
T3
T2
T1
Sub Irrigation Channel
Path
Sub Irrigation Channel
T1
T2
T3
T4
T5
T6
Main Irrigation Channel

Details of Layout - The details of layout for experiment for both the crops i.e. potato and tomato experiments:

Total number of replication	:	3
Total no. of treatment/ replication	:	3
Total number of plots	:	18
Gross experimental area	:	527 m2
Net experimental area	:	360 m2
Area of the individual plot	:	20 m2
Size of the individual plot	:	5 X 4 m
Spacing between blocks	:	1.75 m
Spacing between plots	:	0.50 m
Width of Path	:	0.75 m
Test material	:	(i) Calcium Metalosate
	:	(ii) Multi- Mineral Metalosate

Planting Material :

Potato- Kufri Bahar is planted as the test crop. This variety used as timely to medium-late planting situation. The average yield of the variety is 260 to 280 q/ha. The seed rate of 25q/ha is used.

Tomato- Abhilash vars. is used as the test crop. The variety is hybrid and has the potential to produced 400- 500 q/ha. The seed rate of 200gm/ha, is used for transplanting of tomato crop.

DETAILS OF FIELD OPERATION

Land preparation:

The field is ploughed with a tractor drawn disc plough followed by two cross harrowing and planting. The field is thoroughly leveled by a scrapper before the experiment is laid out. The weeds and other stubbles are picked up by hand in order to get a clean field. The above operation has been done for both of the test crop i.e. potato and tomato. Recommended dose of fertilizers are applied uniformly in the entire experimental crop.

POST PLANTING OPERATION:

Irrigation- The planted plots are irrigated intermittently for two week after planting to maintain optimum moisture in potato crop whereas tomato is irrigated intermittently for one week after transplanting.

Weeding and earthing: Hand weeding is done 25 days after planting in potato and after 15 days in tomato crop. Earthing is done in both the crops manually.

Plant protection measures:

Spray of mancozeb @ 0.2% is carried out twice at fortnightly interval to control late blight attack in potato.

Spray of propheno phos is done twice at 10 days interval @0.1% to control the insects

OBSERVATION:

During the experimental period a number of observations are taken to study the growth and yield parameters of both the crops (potato and tomato) as mention below:

Potato

1. Plant height
2. Average weight of 10 tubers
3. Yield q /ha
4. Quality of tuber(uniformity, size etc)as visual
5. Phyto-tonic effect on crop as visual.
6. Phyto- toxic effect on crop as visual.
7. Treatment wise photographs.

Tomato

1. Plant height
2. No. of fruits per plant
3. Average weight of 10 fruits
4. Yield q/ha.
5. Shelf life study for 30 days
6. Phyto- tonic effect on crops
7. Phyto- toxic effect on crops
8. In seed disease incidence intensity as visual
9. Quality produce- uniformity in shape, size and colour.
10. Treatment wise photographs

STATISTICAL METHOD

Analysis of Data: The observations which provided quantitative data are tabulated and statistically analyzed by analysis of variance technique. The fisher's F test method was followed to test the significance of the experimental F (variance ratio) is compound with the table value of F at 5% and 1% level of significance. If the calculated value is more than that of the table value of F at 5% level of significant, the effect is considered to be significant. Further, it is compared with table value of F at 1% level of significance to see whether it is highly significant or not.

Experiment no 1 : Calcium Metalosate on potato crop

Location :- Krishi Vigyan Kendra, Kaushambi

Date of planting: - 06.12.2014 Plot Size- 4 m X 5 m

Replication wise treatments:

Table 3(A)

Plot No	Detail of treatments	Plot No	Detail of treatments	Plot No	Detail of treatments
6	Control	1	Calcium Metalosate @ 1ml/lt of water	6	Control
5	Chelated mineral @ 1g/lt of water	2	Calcium Metalosate @ 2ml/lt of water	5	Chelated mineral @ 1g/lt of water
4	Amino Acid @ 2ml/lt of water	3	Calcium Metalosate @ 3ml/lt of water	4	Amino Acid @ 2ml/lt of water
3	Calcium Metalosate @ 3ml/lt of water	4	Amino Acid @ 2ml/lt of water	3	Calcium Metalosate @ 3ml/lt of water
2	Calcium Metalosate @ 2ml/lt of water	5	Chelated mineral @ 1g/lt of water	2	Calcium Metalosate @ 2ml/lt of water
1	Calcium Metalosate @ 1ml/lt of water	6	Control	1	Calcium Metalosate @ 1ml/lt of water
R-1		R-2		R-3	

Photographs

Date of planting: 06.12.2014

Date of 1st Spray: 07.01.2015

Date of 2nd Spray: 23.01.2015

Date of 3rd Spray: 07.02.2015

Experiment no 2: Calcium Metalosate on potato crop

Location: Farmers Field Farmer: Radhey Shyam

Village: Bhiti Block: Muratganj

District: Kaushambi Plot Size: 4 m X 5 m

Replication wise treatments:

Table 3(B)

Plot No	Detail of treatments	Plot No	Detail of treatments	Plot No	Detail of treatments
6	Control	1	Calcium Metalosate @ 1ml/lt of water	6	Control
5	Chelated mineral @ 1g/lt of water	2	Calcium Metalosate @ 2ml/lt of water	5	Chelated mineral @ 1g/lt of water
4	Amino Acid @ 2ml/lt of water	3	Calcium Metalosate @ 3ml/lt of water	4	Amino Acid @ 2ml/lt of water
3	Calcium Metalosate @ 3ml/lt of water	4	Amino Acid @ 2ml/lt of water	3	Calcium Metalosate @ 3ml/lt of water
2	Calcium Metalosate @ 2ml/lt of water	5	Chelated mineral @ 1g/lt of water	2	Calcium Metalosate @ 2ml/lt of water
1	Calcium Metalosate @ 1ml/lt of water	6	Control	1	Calcium Metalosate @ 1ml/lt of water
R-1		R-2		R-3	

Photographs

Date of planting: 07.12.2014

Date of 1st Spray: 07.01.2015

Date of 2nd Spray: 22.01.2015

Date of 3rd Spray: 06.02.2015

Statistical Analysis

Table No.- 4(A)

Performance of different treatments of calcium metalosate on potato crop

Treatments	Detail of treatments	KVK Location			Farmers Location		
		Avg. Plant height (cm)	Avg. weight of 10 tubers (g)	Avg. Yield (q/ha)	Avg. Plant height (cm)	Avg. weight of 10 tubers (g)	Avg. Yield (q/ha)
T_1	Calcium Metalosate @ 1ml/lt of water	32.63	824.33	201.47	32.43	826.00	202.30
T_2	Calcium Metalosate @ 2ml/lt of water	32.37	1054.67	242.83	32.53	1021.33	256.00
T_3	Calcium Metalosate @ 3ml/lt of water	36.73	1059.33	253.43	37.10	1055.00	266.60
T_4	Amino Acid @ 2ml/lt of water	30.73	923.67	210.10	31.13	922.33	211.87
T_5	Chelated mineral @ 1g/lt of water	32.20	892.00	231.87	33.53	824.33	233.00
T_6	Control	25.10	821.33	180.17	26.00	817.33	180.10
F Test		**NS**	**S**	**S**	**NS**	**S**	**S**
S. Ed. (±)		-	**1.28**	**0.78**	-	**1.27**	**1.04**
C. D. (P = 0.05)		-	**2.85**	**1.75**	-	**2.83**	**2.32**

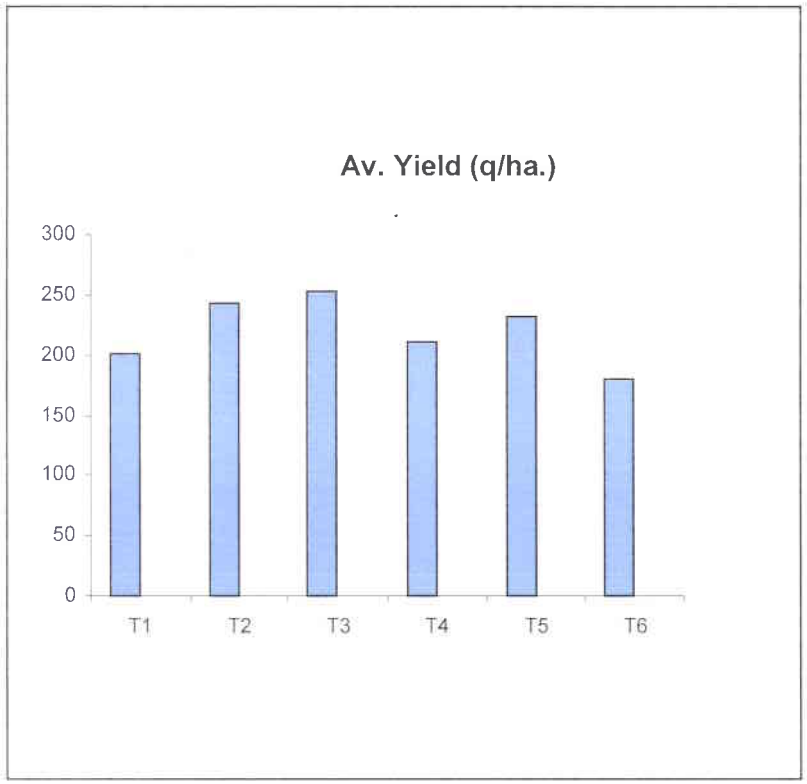
Analysis of Benefit : Cost

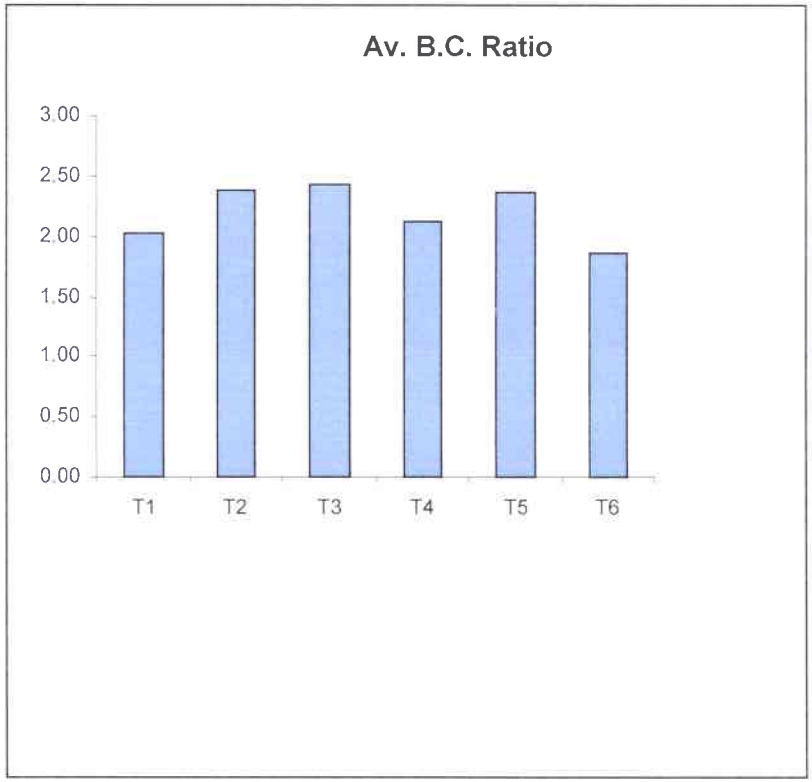
Table- 4(B)

(Rs/ha)

Treatments		KVK Field				Farmer Field			
		Total Cost of cultivation	Gross return(Rs/ha)	Net Return (Rs/ha)	B:C Ratio	Total Cost of cultivation	Gross return(Rs/ha)	Net Return (Rs/ha)	B:C Ratio
T1	Calcium Metalosate @ 1ml/lt of water	64554.00	130955.50	66401.50	2.03	64224.00	127449.00	63225.00	1.98
T2	Calcium Metalosate @ 2ml/lt of water	66228.00	157839.50	91611.50	2.38	66115.00	161406.00	95291.00	2.44
T3	Calcium Metalosate @ 3ml/lt of water	67902.00	164729.50	96827.50	2.43	67812.00	173290.00	105478.00	2.56
T4	Amino Acid @ 2ml/lt of water	64176.00	136565.00	72389.00	2.13	64243.00	133478.10	69235.10	2.08
T5	Chelated mineral @ 1g/lt of water	63582.00	150715.50	87133.50	2.37	63460.00	146790.00	83330.00	2.31
T6	Control	62890.00	117760.50	54870.50	1.87	53870.00	117000.00	63130.00	2.17

Fig. 1 : Yield and Benefit cost ratio of Potato- Calcium Metalosate





The above Figure shows that there is superiority of T3 i.e. 3ml calcium metalosate per liter of water related to yield and B: C ratio over the control.

Result & Discussion of Table- 4(A) & 4(B)

Perusal of table reveals the mean height of plant, weight of 10 tubers and tuber yield under different locations i.e. KVK location and Farmer Field location. The difference in plant height in different treatment has been found non- significant. Although, highest plant height (36.73 cm) was recorded with T3 (Calcium metalosate @ 3ml of water) followed by T1, T2, T5 & T4 respectively and lowest plant height of 25.10 cm is found in T6 (Control plot). Similar trends are also recorded at farmer fields.

Significant difference observed in the average weight of 10 tubers under different treatments. Maximum weight obtained with T3 (1059gm) at all locations. Treatment T2, T4, T5 and T1 were also found better then control at all locations.

Significant difference is recorded in tuber yield in different treatments at all locations i.e. KVK and Farmer Fields. Maximum tuber yield is obtained with T3 (267 q / ha) followed by T2, T5, T4 and T1 at both locations. There was an increased yield of 43.9% over the control. Higher yield in the treated plots may be due to better utilization of nutrients.

Visual observations show dullness in tuber colour with all the treatments of calcium matalosate as compared to amino acid and chelated mineral. Its was noticeable that tubers after putting them in store for one month showed no change in the weight of tubers whereas decreasing weight was noticed in tubers treated with amino acid and chelated mineral. Further, as far as uniformity of the tubers is concerned, calcium metalosate treated plots showed more uniformity among the tubers as compared to amino acid and chelated mineral plots. Phyto-tonic effect on crop with calcium metalosate treatment observed in comparison with other treatments due to which plants showed vigorous growth. However no phyto- toxicity is observed on the crop.

The experiment on use of different doses of calcium metalosate, amino acid and chelated mineral on potato crop shows different trend regarding cost benefit ratio. The maximum cost benefit ratio is observed with T3 treatment followed by T2 and T5 i.e. 3ml, 2ml calcium metalosate and 1gm/lt of water of chelated mineral respectively, while minimum found with control.

Treatment wise Photo graph

T1	Calcium Metalosate @ 1ml/lt of water	
T2	Calcium Metalosate @ 2ml/lt of water	
T3	Calcium Metalosate @ 3ml/lt of water	

T4	Amino Acid @ 2ml/lt of water	
T5	Chelated mineral @ 1g/lt of water	
T6	Control	

Experiment no 3: Multi Mineral Metalosate on Potato Crop

Location: Krishi Vigyan Kendra, Kaushambi

Replication wise treatments: Table – 5(A)

Plot No	Detail of treatments	Plot No	Detail of treatments	Plot No	Detail of treatments
6	Control	1	Multi mineral metalosate @ 1ml/lt of water	6	Control
5	Chelated mineral @ 1g/lt of water	2	Multi mineral metalosate @ 2ml/lt of water	5	Chelated mineral @ 1g/lt of water
4	Amino Acid @ 2ml/lt of water	3	Multi mineral metalosate @ 3ml/lt of water	4	Amino Acid @ 2ml/lt of water
3	Multi mineral metalosate @ 3ml/lt of water	4	Amino Acid @ 2ml/lt of water	3	Multi mineral metalosate @ 3ml/lt of water
2	Multi mineral metalosate @ 2ml/lt of water	5	Chelated mineral @ 1g/lt of water	2	Multi mineral metalosate @ 2ml/lt of water
1	Multi mineral metalosate @ 1ml/lt of water	6	Control	1	Multi mineral metalosate @ 1ml/lt of water
R-1		R-2		R-3	

Photographs

Date of planting: 06.12.2014

Date of 1st Spray: 07.01.2015

Date of 2nd Spray: 23.01.2015

Date of 3rd Spray: 07.02.2015

Experiment no 4: Multi Mineral Metalosate on potato crop

Location: Farmers Field

Farmer: Shri Ram Chandra

Village: Bhiti

Block: Muratganj

District: Kaushambi

Plot Size: 4 m X 5 m

Replication wise treatments: Table 5(B)

Plot No	Detail of treatments	Plot No	Detail of treatments	Plot No	Detail of treatments
6	Control	1	Multi mineral metalosate @ 1ml/lt of water	6	Control
5	Chelated mineral @ 1g/lt of water	2	Multi mineral metalosate @ 2ml/lt of water	5	Chelated mineral @ 1g/lt of water
4	Amino Acid @ 2ml/lt of water	3	Multi mineral metalosate @ 3ml/lt of water	4	Amino Acid @ 2ml/lt of water
3	Multi mineral metalosate @ 3ml/lt of water	4	Amino Acid @ 2ml/lt of water	3	Multi mineral metalosate @ 3ml/lt of water
2	Multi mineral metalosate @ 2ml/lt of water	5	Chelated mineral @ 1g/lt of water	2	Multi mineral metalosate @ 2ml/lt of water
1	Multi mineral metalosate @ 1ml/lt of water	6	Control	1	Multi mineral metalosate @ 1ml/lt of water
R-1		R-2		R-3	

Photographs

Date of Planting: 07.01.2015

Date of 1st Spray: 07.01.2015

Date of 2nd Spray: 22.01.2015

Date of 3rd Spray: 06.02.2015

Statistical Analysis

Table No.- 6 (A)

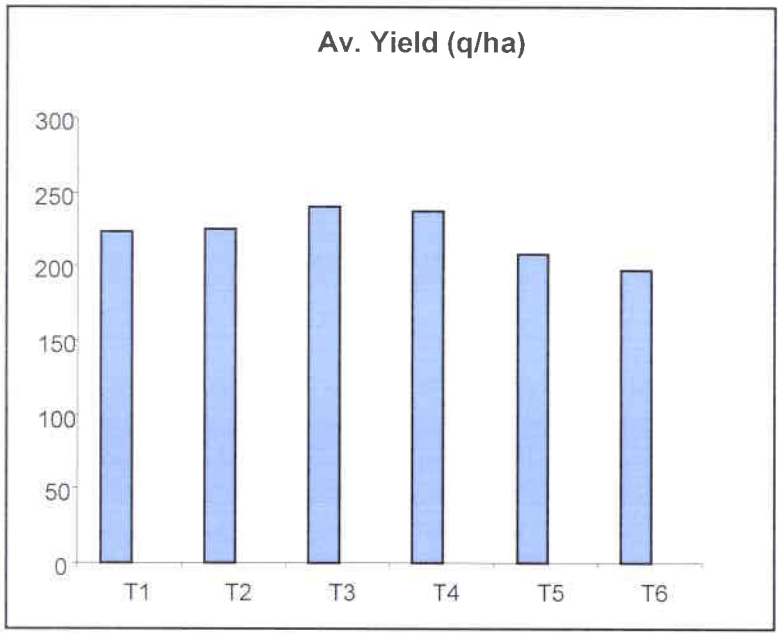
Performance of different treatments of Multi Mineral metalosate on potato crop							
Treatments	Detail of treatments	KVK Location			Farmers Location		
		Avg. Plant height (cm)	Avg. weight of 10 tubers (g)	Avg. Yield (q/ha)	Avg. Plant height (cm)	Avg. weight of 10 tubers (g)	Avg. Yield (q/ha)
T1	Multi mineral metalosate @ 1ml/lt of water	37.33	821.67	223.33	35.33	829.67	220.00
T2	Multi mineral metalosate @ 2ml/lt of water	39.33	1055.00	225.33	38.33	1024.00	223.67
T3	Multi mineral metalosate @ 3ml/lt of water	43.33	1123.00	241.00	42.33	1124.33	243.00
T4	Amino Acid @ 2ml/lt of water	38.67	991.67	236.67	37.33	995.00	238.33
T5	Chelated mineral @ 1g/lt of water	40.67	923.00	208.00	41.67	938.00	208.00
T6	Control	29.00	904.33	197.00	29.00	819.00	196.33
F Test		S	S	S	S	S	S
S. Ed. (±)		0.55	1.95	1.01	0.91	1.73	0.85
C. D. (P = 0.05)		1.23	4.35	2.24	2.02	3.86	1.90

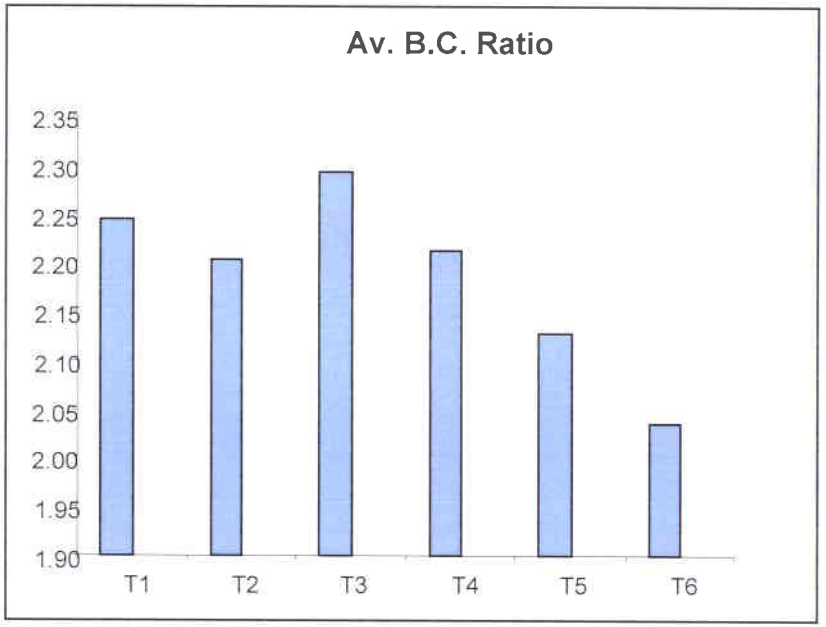
Analysis of Benefit cost

Table- 6(B) **(Rs/ha)**

Treatments		KVK Field				Farmer Field			
		Total Cost of cultivation	Gross return	Net Return	B:C Ratio	Total Cost of cultivation	Gross return	Net Return	B:C Ratio
T1	Multi mineral metalosate @ 1ml/lt of water	64694.00	145164.50	80470.50	2.24	64560.00	143000.00	78440.00	2.21
T2	Multi mineral metalosate @ 2ml/lt of water	66510.00	146464.50	79954.50	2.20	66460.00	145385.50	78925.50	2.19
T3	Multi mineral metalosate @ 3ml/lt of water	68325.00	156650.00	88325.00	2.29	68120.00	160380.00	92260.00	2.35
T4	Amino Acid @ 2ml/lt of water	64176.00	142002.00	77826.00	2.21	65985.00	147764.60	81779.60	2.24
T5	Chelated mineral @ 1g/lt of water	63582.00	135200.00	71618.00	2.13	63430.00	128960.00	65530.00	2.03
T6	Control	62900.00	128050.00	65150.00	2.04	61760.00	121724.60	59964.60	1.97

Fig. 2: Yield and Benefit cost ratio of Potato- Multi Mineral Metalosate





The above figure shows the average yield and B:C Ratio of T3 is superior than T6 (control) and other treatments.

Result and Discussion of Table 6(A) & 6(B)

Perusal of table reveals the mean height of plant, weight of 10 tuber and tuber yield under different locations i.e. KVK location and Farmer Field location. Plant height parameter showed non significant difference in different treatments. Highest plant height (43.33 cm) is recorded with T3 (Multi Mineral metalosate @ 3ml of water) followed by T5, T2, T4,T1 respectively and lowest plant height 29.00 cm in T6(Control). All the treated plants showed better plant height than control. Similar results also recorded at farmer fields.

Significant difference in the average weight of 10 tubers recorded under different treatments. Maximum weight obtained with T3 (1124.33 gm) in both the locations, whereas lowest weight observed in control plot (T6). Treatment T5, T2, T4 and T1 also found better then control at both the locations.

Significant difference observed in tuber yield in different treatments at both the locations. Maximum yield obtained in T3 (266.60qu/ha), followed by T4, T2, T1 and T5 at both the locations, whereas lowest yield recorded in T6 (Control plot). The analysis of table indicates that use of 3ml multi mineral metalosate resulted in increasing yield at both the locations and it was 22.33% over the control.

T3 (Multi mineral metalosate @3ml/lt water) and T4 (Amino acid) showed more uniformity among the tubers than other treatments. Besides uniformity, shine also noticed in tubers in the same treatment as compared to others. Phyto- tonic effect observed in all multi mineral metalosate treated plots specially T3. As per visual observations, no phyto- toxic effect was noticed.

The cost benefit ratio is maximum with T3 treatment followed by T1 and T4 where as minimum is with control at both the locations.

Treatment wise Photographs

T1	Multi mineral metalosate @ 1ml/lt of water	
T2	Multi mineral metalosate @ 2ml/lt of water	
T3	Multi mineral metalosate @ 3ml/lt of water	

T4	Amino Acid @ 2ml/lt of water	
T5	Chelated mineral @ 1g/lt of water	
T6	Control	

Experiment no 5: Calcium Metalosate on Tomato crop

Location : Krishi Vigyan Kendra, Kaushambi

Plot Size- 4 m X 5 m

Replication wise treatments:

Table- 7 (A)

Plot No	*Detail of treatments*	*Plot No*	*Detail of treatments*	*Plot No*	*Detail of treatments*
6	Control	1	Calcium Metalosate @ 1ml/lt of water	6	Control
5	Chelated mineral @ 1g/lt of water	2	Calcium Metalosate @ 2ml/lt of water	5	Chelated mineral @ 1g/lt of water
4	Amino Acid @ 2ml/lt of water	3	Calcium Metalosate @ 3ml/lt of water	4	Amino Acid @ 2ml/lt of water
3	Calcium Metalosate @ 3ml/lt of water	4	Amino Acid @ 2ml/lt of water	3	Calcium Metalosate @ 3ml/lt of water
2	Calcium Metalosate @ 2ml/lt of water	5	Chelated mineral @ 1g/lt of water	2	Calcium Metalosate @ 2ml/lt of water
1	Calcium Metalosate @ 1ml/lt of water	6	Control	1	Calcium Metalosate @ 1ml/lt of water
R-1		R-2		R-3	

Date of planting : 13.12.2014 Date of 1st Spray: 15.01.2015

Date of 2nd Spray: 30.01.2015 Date of 3rd Spray: 14.02.2015

Experiment no 6: Calcium Metalosate on Tomato crop

Location: Farmers Field Farmer Name: Pawan
Village: Pateriya Block: Chail
District: Kaushambi Plot Size: 4 m X 5 m

Replication wise treatments:Table 7(B)

Plot No	Detail of treatments	Plot No	Detail of treatments	Plot No	Detail of treatments
6	Control	1	Calcium Metalosate @ 1ml/lt of water	6	Control
5	Chelated mineral @ 1g/lt of water	2	Calcium Metalosate @ 2ml/lt of water	5	Chelated mineral @ 1g/lt of water
4	Amino Acid @ 2ml/lt of water	3	Calcium Metalosate @ 3ml/lt of water	4	Amino Acid @ 2ml/lt of water
3	Calcium Metalosate @ 3ml/lt of water	4	Amino Acid @ 2ml/lt of water	3	Calcium Metalosate @ 3ml/lt of water
2	Calcium Metalosate @ 2ml/lt of water	5	Chelated mineral @ 1g/lt of water	2	Calcium Metalosate @ 2ml/lt of water
1	Calcium Metalosate @ 1ml/lt of water	6	Control	1	Calcium Metalosate @ 1ml/lt of water
R-1		R-2		R-3	

Date of planting: 13.12.2014 **Date of 1st Spray: 12.01.2015**
Date of 2nd Spray: 28.01.2015 **Date of 3rd Spray: 13.02.2015**

Statistical Analysis
Table 8(B)

Performance of different treatments of Calcium metalosate on tomato crop							
Treatments	Detail of treatments	*KVK Location*			*Farmers Location*		
		Avg. Plant height (cm)	*Days required 50% flowering*	*No. of fruits/ plant*	*Avg. Plant height (cm)*	*Days required 50% flowering*	*No. of fruits/plant*
T1	Calcium Metalosate @ 1ml/lt of water	85.30	34.00	139.33	84.40	35.67	80.33
T2	Calcium Metalosate @ 2ml/lt of water	88.50	35.33	135.33	87.47	38.33	84.00
T3	Calcium Metalosate @ 3ml/lt of water	93.60	32.00	162.33	91.03	32.00	92.33
T4	Amino Acid @ 2ml/lt of water	88.97	43.67	140.33	87.73	53.67	88.00
T5	Chelated mineral @ 1g/lt of water	86.13	47.67	142.00	85.67	57.33	88.67
T6	Control	81.47	48.33	132.67	80.03	61.00	65.33
F Test		NS	S	S	NS	S	S
S. Ed. (±)		-	2.03	2.12	-	1.94	1.82
C. D. (P = 0.05)		-	4.52	4.72	-	4.32	4.06

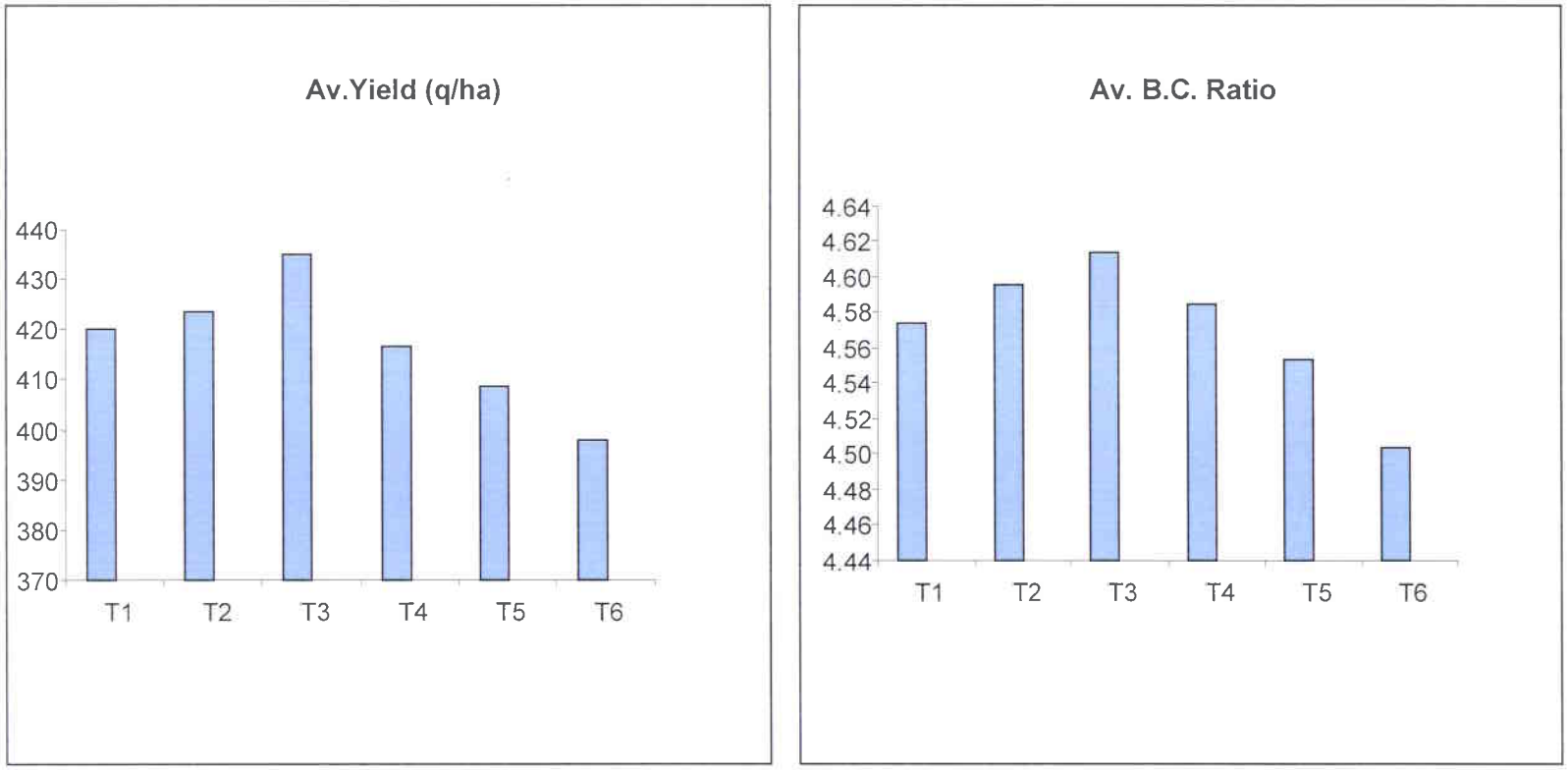
Treatments	Detail of treatments	KVK Location		Farmers Location	
		Weight of 10 fruits (g)	Avg. Yield (q/ha)	Weight of 10 fruits (g)	Avg. Yield (q/ha)
T1	Calcium Metalosate @ 1ml/lt of water	558.33	420.00	507.33	407.00
T2	Calcium Metalosate @ 2ml/lt of water	437.67	423.67	410.33	420.67
T3	Calcium Metalosate @ 3ml/lt of water	600.33	435.00	697.67	436.67
T4	Amino Acid @ 2ml/lt of water	502.00	416.67	500.00	413.33
T5	Chelated mineral @ 1g/lt of water	564.00	408.67	384.67	402.00
T6	Control	418.33	398.00	413.00	397.67
F Test		S	S	S	S
S. Ed. (±)		1.91	1.67	1.87	1.76
C. D. (P = 0.05)		4.26	3.71	4.18	3.93

Analysis of Benefit: Cost

Table 8(B) **(Rs/ha)**

Treatments		KVK Field				Farmer Field			
		Total Cost of cultivation	Gross return	Net Return	B:C Ratio	Total Cost of cultivation	Gross return	Net Return	B:C Ratio
T1	Calcium Metalosate @ 1ml/lt of water	72074.00	329700.00	257626.00	4.57	71650.00	321530.00	249880.00	4.49
T2	Calcium Metalosate @ 2ml/lt of water	73748.00	338936.00	265188.00	4.60	73275.00	332329.30	259054.30	4.54
T3	Calcium Metalosate @ 3ml/lt of water	75422.00	348000.00	272578.00	4.61	74992.00	344969.30	269977.30	4.60
T4	Amino Acid @ 2ml/lt of water	72696.00	333336.00	260640.00	4.59	71460.00	326846.70	255386.70	4.57
T5	Chelated mineral @ 1g/lt of water	71802.00	326936.00	255134.00	4.55	71745.00	317580.00	245835.00	4.43
T6	Control	70700.00	318400.00	247700.00	4.50	70560.00	314159.30	243599.30	4.45

Fig. 3: Yield and Benefit cost ratio of Tomato- Calcium Metalosate



The above figure shows the performance of different treatments on yield and B: C ratio. Treatment T3 has superiority in relation to yield and B: C Ratio over the control and other treatments.

Result & Discussion of Table – 8A & 8(B)

Perusal of table reveals the mean height of plant, days required for 50% flowering, no. of fruits /plant, weight of 10 fruits and yield under different locations & treatments. Non significant difference in the plant height observed in different treatments. Highest plant height (93.60 cm) recorded with T3 (Calcium metalosate @ 3ml of water) followed by T4, T2, T5,T1 respectively and lowest plant height 81.47 cm measured in T6 (control). All the treated plots showed better plant height than control. Similar results also recorded at farmer fields as well.

Significant difference found in days required for 50% flowering under different treatments. Minimum days required for 50% flowering recorded in T3 (32days) and maximum days required for 50% flowering found in control plot T6 (61 days) at both the location. Treatment T1, T2, T4 and T5 performed better than control at both the locations.

Data above indicates significant difference in the number of fruits/plant in different treatments. Maximum number of fruits/ plant obtained with T3 (162) in both the locations, whereas, lowest number of fruits/plant found in control plot (T6) at both the locations.

Significant difference in the average weight of 10 fruits recorded in different treatments. Maximum weight obtained in T3 (698 gm) at both the location, whereas minimum weight found in control plot (T6). Treatments T5, T2, T4 and T1 also performed superior to control at both the locations.

Significant difference observed in tuber yield in different treatments at both the locations location. Maximum yield obtained in T3 (437q /ha) followed by T2, T1, T4 and T5. Whereas, minimum yield recorded in T6 (Control plot). The percentage increase in yield of T3 treatment was 9.4% over control. The higher yield observed with T3 treatment may be due to better utilization of nutrient which helped in healthy crop.

As regards to the shelf life of tomato fruit, no difference found in treatments as per visual observations. No phyto- toxic effect observed in different treatments. However, we didn't notice the phyto-tonic effect on the plants under any treatments. As per our visual observation incidence of insect, disease was lesser among the treated plants as compared to untreated plots.

The economic analysis shows that treatment T3 was found most economical as compared to all other treatments.

Treatment Wise Photographs

T1	Calcium Metalosate @ 1ml/lt of water	
T2	Calcium Metalosate @ 2ml/lt of water	
T3	Calcium Metalosate @ 3ml/lt of water	

T4	Amino Acid @ 2ml/lt of water	
T5	Chelated mineral @ 1g/lt of water	
T6	Control	

Experiment no 7: Multi -Mineral Metalosate in Tomato crop

Location:- Krishi Vigyan Kendra

Plot Size: 4 m X 5 m

Replication wise treatments:

Table-9(A)

Plot No	Detail of treatments	Plot No	Detail of treatments	Plot No	Detail of treatments
6	Control	1	Multi mineral metalosate @ 1ml/lt of water	6	Control
5	Chelated mineral @ 1g/lt of water	2	Multi mineral metalosate @ 2ml/lt of water	5	Chelated mineral @ 1g/lt of water
4	Amino Acid @ 2ml/lt of water	3	Multi mineral metalosate @ 3ml/lt of water	4	Amino Acid @ 2ml/lt of water
3	Multi mineral metalosate @ 3ml/lt of water	4	Amino Acid @ 2ml/lt of water	3	Multi mineral metalosate @ 3ml/lt of water
2	Multi mineral metalosate @ 2ml/lt of water	5	Chelated mineral @ 1g/lt of water	2	Multi mineral metalosate @ 2ml/lt of water
1	Multi mineral metalosate @ 1ml/lt of water	6	Control	1	Multi mineral metalosate @ 1ml/lt of water
R-1		R-2		R-3	

Photographs

Date of planting: 13.12.2014

Date of 1st Spray: 15.01.2015

Date of 2nd Spray: 30.01.2015

Date of 3rd Spray: 14.02.2015

Experiment no 8: Multi- Mineral Metalosate on tomato crop

Location	: Farmers Field	Farmer	: Rakesh Kumar
Village	: Patariya	Block	: Chail
District	: Kaushambi	Plot Size	: 4 m X 5 m

Replication wise treatments:

Table 9(B)

Plot No	Detail of treatments	Plot No	Detail of treatments	Plot No	Detail of treatments
6	Control	1	Multi mineral metalosate @ 1ml/lt of water	6	Control
5	Chelated mineral @ 1g/lt of water	2	Multi mineral metalosate @ 2ml/lt of water	5	Chelated mineral @ 1g/lt of water
4	Amino Acid @ 2ml/lt of water	3	Multi mineral metalosate @ 3ml/lt of water	4	Amino Acid @ 2ml/lt of water
3	Multi mineral metalosate @ 3ml/lt of water	4	Amino Acid @ 2ml/lt of water	3	Multi mineral metalosate @ 3ml/lt of water
2	Multi mineral metalosate @ 2ml/lt of water	5	Chelated mineral @ 1g/lt of water	2	Multi mineral metalosate @ 2ml/lt of water
1	Multi mineral metalosate @ 1ml/lt of water	6	Control	1	Multi mineral metalosate @ 1ml/lt of water
R-1		R-2		R-3	

Photographs

Date of planting: 13.12.2014

Date of 1st Spray: 12.01.2015

Date of 2nd Spray: 28.01.2015

Date of 3rd Spray: 13.02.2015

Statistical Analysis
Table No.- 10(A)

Performance of different treatments of Multi mineral metalosate on tomato crop							
Treatments	Detail of treatments	KVK Location			Farmers Location		
		Avg. Plant height (cm)	Days required 50% flowering	No. of fruits/plant	Avg. Plant height (cm)	Days required 50% flowering	No. of fruits/plant
T1	Multi mineral metalosate @ 1ml/lt of water	93.80	35.67	101.67	78.03	36.00	100.33
T2	Multi mineral metalosate @ 2ml/lt of water	91.17	36.00	130.33	76.80	37.00	132.33
T3	Multi mineral metalosate @ 3ml/lt of water	97.95	34.00	142.33	83.67	34.00	143.00
T4	Amino Acid @ 2ml/lt of water	88.33	43.67	122.00	74.70	39.33	120.33
T5	Chelated mineral @ 1g/lt of water	93.33	44.67	116.33	73.53	46.00	117.67
T6	Control	76.27	46.33	110.33	69.07	48.33	97.67
F Test		S	S	S	S	S	S
S. Ed. (±)		1.07	1.09	1.73	0.98	1.47	1.56
C. D. (P = 0.05)		2.38	2.43	3.86	2.19	3.27	3.48

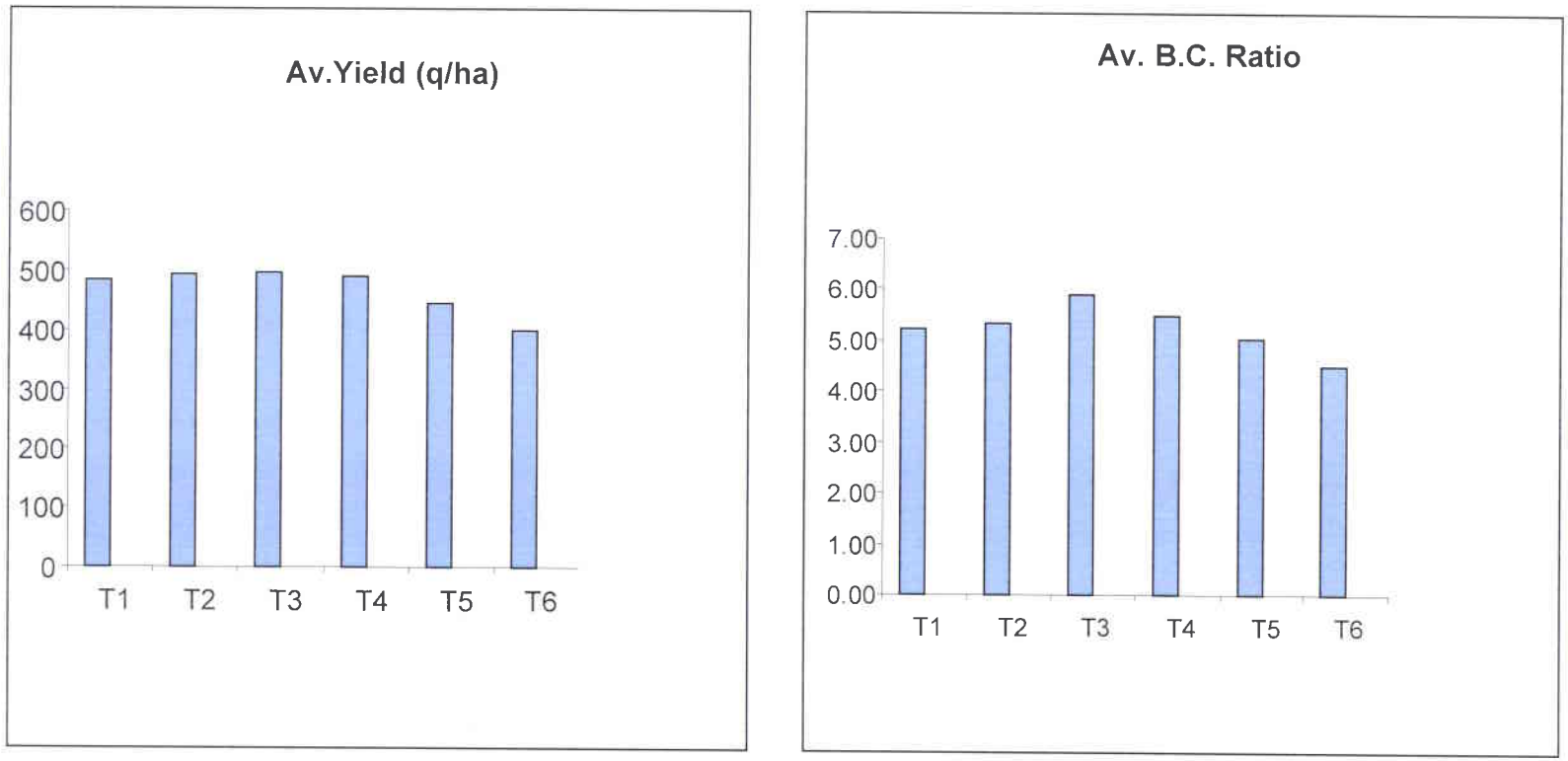
Treatments	Detail of treatments	KVK Location		Farmers Location	
		Weight of 10 fruits (g)	Avg. Yield (q/ha)	Weight of 10 fruits (g)	Avg. Yield (q/ha)
T1	Multi mineral metalosate @ 1ml/lt of water	598.67	484.00	595.33	485.00
T2	Multi mineral metalosate @ 2ml/lt of water	499.67	494.33	523.33	493.67
T3	Multi mineral metalosate @ 3ml/lt of water	605.00	497.67	657.67	497.00
T4	Amino Acid @ 2ml/lt of water	597.33	491.00	534.00	490.00
T5	Chelated mineral @ 1g/lt of water	501.00	445.67	520.33	445.67
T6	Control	497.33	398.67	404.33	399.00
F Test		S	S	S	S
S. Ed. (±)		2.08	1.96	2.44	1.74
C. D. (P = 0.05)		4.63	4.36	5.43	3.87

Analysis of Benefit : Cost

Table 10(B) **(Rs/ha)**

Treatments		KVK Field				Farmer Field			
		Total Cost of cultivation	Gross return	Net Return	B:C Ratio	Total Cost of cultivation	Gross return	Net Return	B:C Ratio
T1	Multi mineral metalosate @ 1ml/lt of water	72814.00	387200.00	314386.00	5.32	72140.00	383150.00	311010.00	5.31
T2	Multi mineral metalosate @ 2ml/lt of water	74028.00	395464.00	321436.00	5.34	73982.00	389999.30	316017.30	5.27
T3	Multi mineral metalosate @ 3ml/lt of water	75843.00	447903.00	372060.00	5.91	75640.00	422450.00	346810.00	5.59
T4	Amino Acid @ 2ml/lt of water	71696.00	392800.00	321104.00	5.48	71860.00	387100.00	315240.00	5.39
T5	Chelated mineral @ 1g/lt of water	71102.00	356536.00	285434.00	5.01	70920.00	352079.30	281159.30	4.96
T6	Control	70400.00	318136.00	247736.00	4.52	70340.00	315210.00	244870.00	4.48

Fig. 4 : Yield and Benefit cost ratio of Tomato-Multi Mineral Metalosate



Treatment T3 showing its superiority over control and other treatments.

Result & Discussion of Table 10(A) & 10(B)

Perusal of table reveals the mean height of plant, days required 50% flowering, No of fruit /plant, weight of 10 fruit and yield under different location i.e. KVK location and Farmer Fields. Plant height difference found to be non significant in different treatments. Highest plant height (97.95 cm) recorded with T3 (Multi mineral metalosate @ 3ml of water) followed by T1, T5, T2, T4 and lowest plant height of 76.27 cm in T6 (Control). All the treated plants showed better plant height than control (untreated). Similar result also recorded at farmer field.

Significant difference found in days required for 50% flowering under different treatments. Minimum days required for 50% flowering recorded with T3 (34 days) and maximum days required for 50% flowering with control plot T6 (48.33 days) at both the locations. Treatment T3 followed by T1, T2, T4 and T5 respectively, found better than control at both the locations.

Also, significant difference observed in the number of fruit/plant under different treatments. Maximum number of fruit/ plant obtained with T3 (143) at both the locations, whereas, it was minimum with control plot (T6).

Significant difference also recorded in the average weight of 10 fruits under different treatments. Maximum weight obtained with T3 (658 gm) at both the location, whereas, it minimum found in control plot (T6). Treatment T3 followed by T1, T4, T5 and T2 performed better than control at both the locations.

Significant difference observed in tuber yield in different treatments at both the locations. Maximum yield obtained in T3 (498 qu /ha) followed by T2, T4, T1 and T5 at both the locations, whereas, minimum yield recorded at T6 (Control plot) and increase in yield percentage was 24.85 over the control. The higher yield may be due to maximum utilization of nutrients.

As regards to the shelf life of tomato fruit, there has been no difference among the treatments as per our visual observations. Phytotonic effect on the growth of the plant with all the treatments i.e. treated with multi mineral metalosate and amino acid was observed. Vigorous plant growth observed in the treated plots as compared to untreated. No incidence of pest and diseases found in the treated plots. No toxicity was noticed under different treatments.

Economic analysis shows that maximum benefit cost ratio observed with T3 treatment at both the location whereas, minimum is found with control.

Treatment wise Photographs

T1	Multi mineral metalosate @ 1ml/lt of water	
T2	Multi mineral metalosate @ 2ml/lt of water	
T3	Multi mineral metalosate @ 3ml/lt of water	

T4	Amino Acid @ 2ml/lt of water	
T5	Chelated mineral @ 1g/lt of water	
T6	Control	

Treatment wise soil analysis post completion of experiment

After completion of experiments soil samples were analyzed for each treatment to find out the variations in fertility status. However, soil test values do not show any significant variations in different treatments and also when compared with soil test values prior to experiments. Soil test values post experiment are shown in table below:

Experiment: Calcium Metalosate in Potato crop

Table- 11(A)

Ingredient	Treatments					
	T1	T2	T3	T4	T5	T6
Available Nitrogen (kg)	113.2	119.2	102.2	110.7	116.4	122.1
Available phosphorus (kg)	10.5	10.0	9.6	10.0	9.6	9.0
Available Potash (kg)	230	225	205	220	195	195
Available Copper (ppm)	0.38	0.44	0.42	0.34	0.31	0.20
Available Iron (ppm)	5.8	5.9	5.92	5.65	4.68	2.25
Available Manganese (ppm)	4.8	4.86	4.22	3.95	3.90	2.8
Available Zinc (ppm)	1.8	1.86	1.75	1.40	1.10	0.65

Experiment: Multi Mineral Metalosate in Potato crop

Table- 11(B)

Ingredient	Treatments					
	T1	T2	T3	T4	T5	T6
Available Nitrogen (kg)	139.1	136.3	142.1	139.1	116.4	110.76
Available phosphorus (kg)	13	11	14	11	10	9
Available Potash (kg)	240	230	210	215	190	210
Available Copper (ppm)	0.45	0.43	0.36	0.36	0.31	00.16
Available Iron (ppm)	7.9	7.65	6.45	6.20	6.18	2.36
Available Manganese (ppm)	4.85	4.55	3.90	3.86	3.75	3.01
Available Zinc (ppm)	1.85	1.45	1.39	1.15	1.20	0.60

Experiment: Calcium Metalosate in Tomato crop
Table- 12(A)

Ingredient	Treatments					
	T1	T2	T3	T4	T5	T6
Available Nitrogen (kg)	130.6	113.6	102.24	107.9	105.1	139.1
Available phosphorus (kg)	18	15	17	16	19	21
Available Potash (kg)	118	115	114	117	118	125
Available Copper (ppm)	0.50	0.45	0.42	0.46	0.43	0.28
Available Iron (ppm)	7.60	7.32	7.10	7.14	7.00	3.35
Available Manganese (ppm)	4.58	4.46	4.10	4.15	4.00	2.90
Available Zinc (ppm)	1.90	1.65	1.45	1.94	1.80	0.96

Experiment: Multi Mineral Metalosate in Tomato crop
Table- 12(B)

Ingredient	Treatments					
	T1	T2	T3	T4	T5	T6
Available Nitrogen (kg)	113.6	107.92	96.56	107.9	96.5	124.9
Available phosphorus (kg)	21	19	18	17	21	26
Available Potash (kg)	185	178	170	180	183	195
Available Copper (ppm)	0.40	0.36	0.35	0.30	0.35	0.28
Available Iron (ppm)	7.90	7.80	7.68	7.70	7.73	3.25
Available Manganese (ppm)	4.67	4.30	4.10	4.18	4.05	2.95
Available Zinc (ppm)	1.40	1.30	1.25	1.30	1.19	0.80