Original Research Article

PERFORMANCE OF GLUCONATE AND LACTATE BASED FORMULATIONS ON PLANT GROWTH AND YIELD ATTRIBUTES IN MAIZE (*Zea mays* L.)

Abstract

Aim/Objectives: To check the efficacy of gluconates and lactate based formulations on plant growth and yield characteristics of maize

Study Design: Randomized Block Design

Place and Duration of Study: School of Agricultural Sciences, Malla Reddy University, Hyderabad, rabi 2021

Methodology: The experiment was laid-out in Randomized Block Design (RBD), with Maize hybrid (DHM-117) spacing adopted (60 x 20 cm) with 4 replications. The treatments viz; T_1: Control (No fertilizer), T_2:100 % RDF, T_3: 75 % RDF + 25 % Sahasra Organic Formulations (SOF), T_4:50 % RDF + 50 % SOF, T_5: 25 % RDF + 75 % SOF, T_6: 100 % SOF. The RDF (N:72-80; P:24; K:20 kg/acre).

Results: The yield attributes were recorded intermittently and maximum grain yield (7,649.8 kg ha^{-1}) and Stover yield (8,859.87 kg ha^{-1}) were recorded with T_2 (100% RDF), followed by T_3 (75 % RDF + 25 % Sahasra Organic Formulations). Similarly gross returns (₹ 123606.5 ha^{-1}), net returns (₹ 87116.49 ha^{-1}) and B: C (3.4) ratio was also recorded highest in T_2 followed by T_3 (75 % RDF + 25 % SOF), while the lowest were recorded with T_1 (control).

Conclusion: Adoption of gluconate and lactate based formulations enhanced soil fertility, soil organic carbon and yield in Maize crop. The study concludes that the integrated approach *i.e.*, T_3 (75 % RDF + 25 % SOF) has realized highest net returns (₹ 82466.8 ha^{-1}) and B:C ratio (3.4) in comparision to 100 % RDF treatment thus reducing the cost of fertilizers and benefiting the net returns to the farmers.

Key words: Gluconates, Lactates, Innovative Technologies, Soil Fertility, Net Returns.

1 Introduction

Maize is grown almost all over the world in different agro-climatic conditions and in different seasons. It is the third most important food crop next to rice and wheat. It is also known as

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the miracle crop or queen of cereals due to its high productivity potential among the cereal crops of Graminacea family. In India, maize is not only grown for food and fodder but also for several industrial usage and acquired dominant role in the farming sector and macro-economy of the Asian region (Mauria*et al.*, 1998). Furthermore,oneofthemostcriticalelementsinfluencingmaizecropdevelopmentandyieldproductivityisfertilizermanagement(Ghosh*et al.*, 2020).ThecurrentNPKfertilizerconsumptionratiois10:2.9:1asagainstoptimalratioof4:2:1(WaliaandKler,2010).Maize area and production have steadily increased in India during the past two decades and it is cultivated in an area of 9.2 M ha with an average production of 28.7 Mt and productivity of 3115 kg ha^{-1}.Thisnon-judiciousnutrientapplicationbyfarmerscauses multi-nutrient deficiencies. In this context, smartuseofintegratednutrientmanagement and use of organic formulations isoneofthegreatestoptionsforensuringlong-termcropproductivity,whilemaintainingsoil fertility in maize and other cereal-basedcropping systems. This ultimately improves crop yield(GarimaandPant,2018). Cultivation of rabi maize is a common practice in Peninsular India (Telangana, Andhra Pradesh, Karnataka and Tamil Nadu) as well as in North Eastern plains, where the winter remains frost free and temperature does not fall below 12˚C.

1.1 Gluconic acid based formulations:

Among various organic acids, gluconic acid seems to be the major mechanism of phosphate solubilizationby gram negative bacteria (Goldstein*et al.*, 1993; Kim*et al.*, 1997). Gluconic acid is produced by the oxidative metabolism of glucose dehydrogenase enzyme through microbial fermentation with different types of *Aspergillusniger* strains.

1.2 Lactic acid based formulations:

Different strains of Lactobacilli are used for Lactic acid production. Lactic acid bacteria have also been used for the treatment of animal manures, farm yard manure and sewage for odor abatement and as an inoculant to accelerate the composting of organic wastes (Okada, 1998).

1.3 Amino acids based formulations:

The chelating ability of amino acids has been used infertilizers for agriculture to facilitate the delivery of minerals to plants in order to correct mineral deficiencies, such as iron chlorosis and other nutrient deficiencies. These fertilizers are also used to prevent deficiencies from occurring and improving the overall health of the plants (Ashmead, H. DeWayne,1986). Amino acids can be extracted from marine algae like sea weeds (*Ascophylumnodosum*), plant like soybean, maize gluten, protein cake from vegetable oil industries and animal proteins.

1.4 Protein lacto gluconate Nutrients:

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Several organic carbon (OC) rich formulations tailored with amino acids, gluconic and lactic acids blended with elemental Nitrogen(N), phosphorous(P), potassium(K) , sulfur(S), calcium(Ca), magnesium(Mg), boron(B), copper(Cu), iron(Fe), molybdenum(Mo), manganese(Mn) etc., were produced from research & development based biotech industries. These formulations were proved through bio-efficacy studies by several national and international agriculture universities and research laboratories on various crop systems andenvironmental conditions.

The experiment will be conducted to study the efficacy of integrated usage of the recommended dose of fertilizers and Lacto gluconate based organic formulations on Maize. The study will focus on growth and development in terms of soil physico chemical characteristics, microbial characteristics, plant growth parameters, yield attributes and post harvest parameters.

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2. Material and Methods:

2.1 Preamble

The experiment will be conducted to study the efficacy of integrated usage of the recommended dose of fertilizers and Lactate,Gluconate based organic formulations on Maize. The study will focus on growth and development interms of plant growth and yield attributes.

2.2 Location

The experimental siteMalla Reddy University is situated in Southern Telangana Agro Climatic Zone at longitude - 78°46′22.69″ E (78.772971), latitude - 17°21′9.86″N (17.352743)with an altitude of 547 meters above Mean Sea Level.

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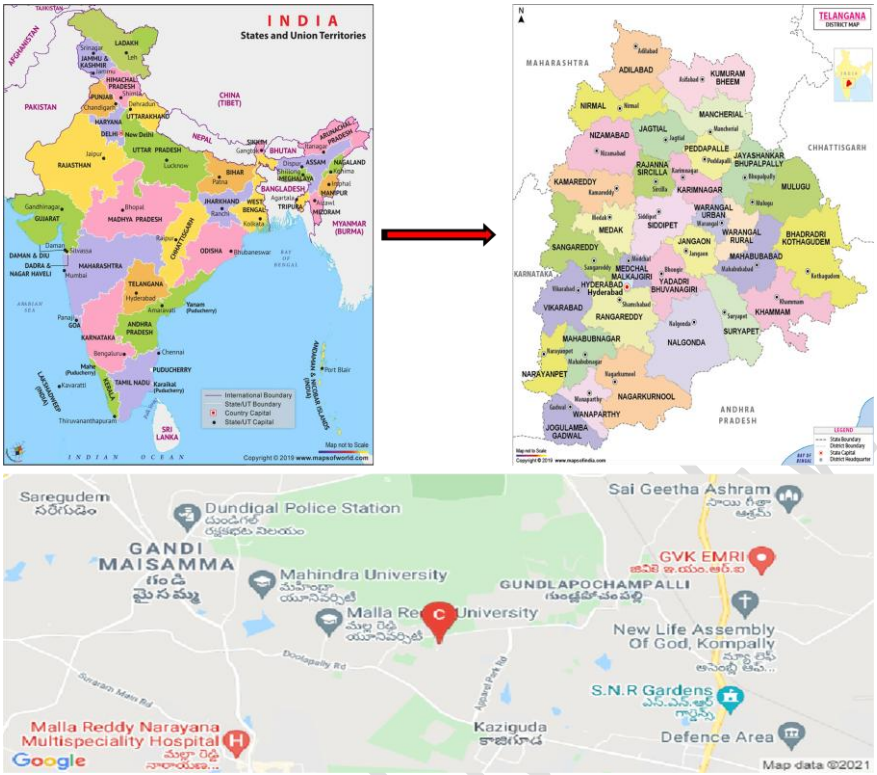

Fig. 1. Location map of field experiment

2.3 Crop and Variety

Maize variety, DHM-117 a short duration high yielding genotype suitable for *kharif*and *rabi* seasons was used for the field experiment.

2.4 Experimental details:

Table 1. Experimental details of Maize crop

S.No.	Particulars	Details
1.	Year of Experiment	2021-22
2.	Crop	Maize
3.	No. of Treatments	6
4.	No. of Replications	4
5.	Spacing	60×20 cm
6.	Experimental Design	Randomized Block Design
7.	Season	*kharif*-2021

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8.	Variety	DHM-117
9.	Location	Malla Reddy University, Telangana

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Treatment Details:

T_1: Control (No fertilizer)

T_2: 100 % RDF

T_3: 75 % RDF + 25 % SahasraOrganic Formulations

T_4: 50 % RDF + 50 % SahasraOrganic Formulations

T_5: 25 % RDF + 75 % SahasraOrganic Formulations

T_6: 100 % SahasraOrganic Formulations

Recommended Dose of Fertilizer (kg/acre) N:72-80; P:24; K:20

2.5 SahasraOrganic Products:

Sahasra organic products i.e., Organic manure, Sage, Nutri and Poshak were formulated and supplied by Sahasra crop science, Hyderabad for testing the efficacy of the products for improving the soil health and yield.

Table 2. Details of Sahasra Organic Formulations

S.No.	Crop	Product	Dosage	Time of Application	Spraying Intervals
1.	Maize	Organic Manure	50 kg/acre	Basal Dose (Before sowing)	Single Dose
		Sage	3 ml/lit	20, 40, 60 DAS	Three Sprays
		Poshak	3 ml/lit	30 & 40 DAS	Two Sprays
		Nutri	2 ml/lit	20 & 40 DAS	Two Sprays

*Coragen 10 DAS (for fall army warm)

Spraying Schedule:

20, 40 & 60 Days After Sowing

Note:

Organic Manure(50 kg/acre as Basal Application)**; Sage** (3 ml/lit at 20-40-60 DAS)**; Nutri**(2 ml/lit at 20 & 40 DAS)**; Poshak**(3 ml/lit at 30 & 40 DAS)**;** If micronutrient deficiency observed on leaves additional spray can be given.

Crop raised as per recommended package of practices of the University. All the recommended agronomic practices uniformly followed for all treatments viz; hoeing, interculture operations, weedicides application and irrigations. For data recording five sample plants and cobs were identified randomly collected and stacked separately for sun drying and

various observations for treatment evaluation were recorded as per experimental design. The data were statistically analyzed by standard tools for interpretation of the results. Data recorded from the experimental identified plants in each sub-plot were randomly selected and taken average weight of all the cobs weight per plant^{-1}, no.of cobs per plant, cob length (cm), cob girth (cm), No. of kernels cob^{-1}, grain (kg ha^{-1}) and stover yield (kg ha^{-1}).

2.6 Grain yield It was noted by weighing the grains shelled from the cobs obtained from the central four rows of each sub-plot and converted it into kg ha^{-1}.

2.7 Biological yield recorded by weighing the sun dried plants along with ears obtained from central four rows of each sub-plot. The biological yield thus obtained in each sub-plot was converted into kg ha^{-1}.

2.8 Harvest Index (%)

HI (%) = Grain yield/Biological yield x 100 (Reddy, 2004)

2.9 Statistical analysis

The data obtained from the field experiment was subjected to statistical analysis. Wherever the treatments difference were significant, Critical differences were worked out at 0.05 per cent probability level and the values were furnished. The treatment differences that were not significant at five per cent were denoted as "NS". Brief interpretation of the results was given at the end of each parameter.

3. Results and Discussion

3.1 Plant Height (cm)

Table 3. Plant height of maize crop under different stages of crop growth

Plant height (cm)	6th Leaf	Silk stage	Dough stage	Maturity
T_1	34.1	130.8	82.4	142.6
T_2	45.8	171.1	108.4	178.1
T_3	42.6	172.2	107.4	185.6
T_4	40.3	160.1	100.2	165.4
T_5	38.1	143.9	91.0	158.1
T_6	37.7	138.9	88.3	149.8
C.D.	**1.755**	**6.850**	**5.286**	**17.476**
SE(m)	0.577	2.252	1.738	5.475
SE(d)	0.816	3.185	2.458	7.743
C.V.	**2.904**	**2.947**	**2.171**	**5.675**

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The increased plant height among all the treatments on 6th leaf stage was observed in T_2 (100 % RDF) 45.8 cm, T_3 (75 % RDF + 25 % Sahasra Organic Formulations) 172.2 cm on silking stage, T_2 (100 % RDF) 108.4 cm on dough stage and in T_3 (75 % RDF + 25 % Sahasra Organic Formulations) 185.6 cm at maturity stage.

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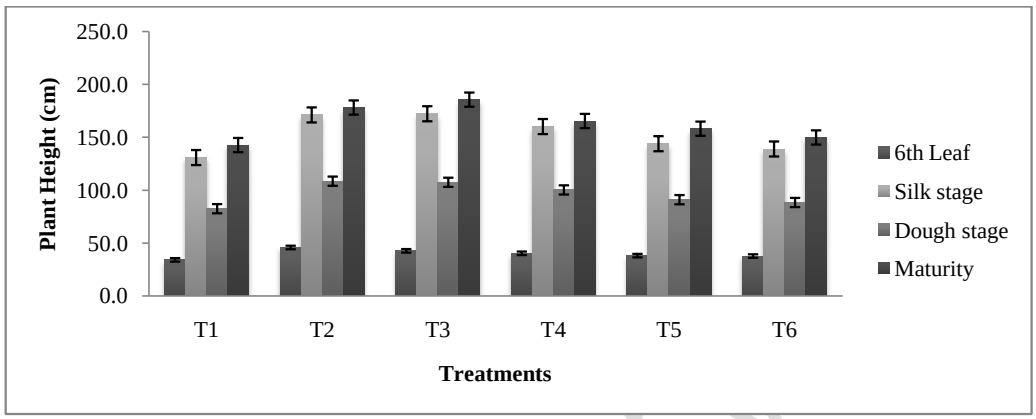

Fig. 2. Plant height of maize crop under different stages of crop growth

Table 4. Yield attributes of maize (*Zea mays* L.) as influenced by different doses of fertilizers andSahasra Organic formulations.

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Treatments	No.of Cobs/ plant	Cob length (cm)	Cob girth (cm)	Cob weight (g)	No. of Kernels/Cob	Grain yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Test weight (g)	Harvest Index (%)
T_1	9.6	16.5	11.7	128.3	457.4	4,808.2	7,835.60	29.1	38.03
T_2	11.9	19.8	14.5	175.9	550.7	7,649.8	8,859.87	31.5	46.34
T_3	11.8	20.7	14.3	180.6	554.6	7,241.3	8,850.63	31.8	45.00
T_4	10.4	18.8	13.9	167.6	526.3	7,019.9	8,394.90	30.4	45.54
T_5	10.2	18.0	13.2	157.3	509.1	6,763.6	8,252.73	30.4	45.04
T_6	10.4	16.9	12.1	142.2	494.2	6,179.1	8,049.30	30.2	43.43
SE.m±	**0.388**	**0.305**	**0.186**	**2.457**	**7.546**	**136.68**	**31.179**	**0.395**	**1.172**
CD (P=0.05)	**1.238**	**0.975**	**0.593**	**7.842**	**24.085**	**415.75**	**99.515**	**1.260**	**3.741**

T_1: Control (No fertilizer), T_2: 100 % RDF, T_3: 75 % RDF + 25 % Sahasra Organic Formulations, T_4: 50 % RDF + 50 % Sahasra Organic Formulations, T_5: 25 % RDF + 75 % Sahasra Organic Formulations,T_6: 100 % Sahasra Organic Formulations. Recommended Dose of Fertilizer (kg/acre) N:72-80; P:24 K:20

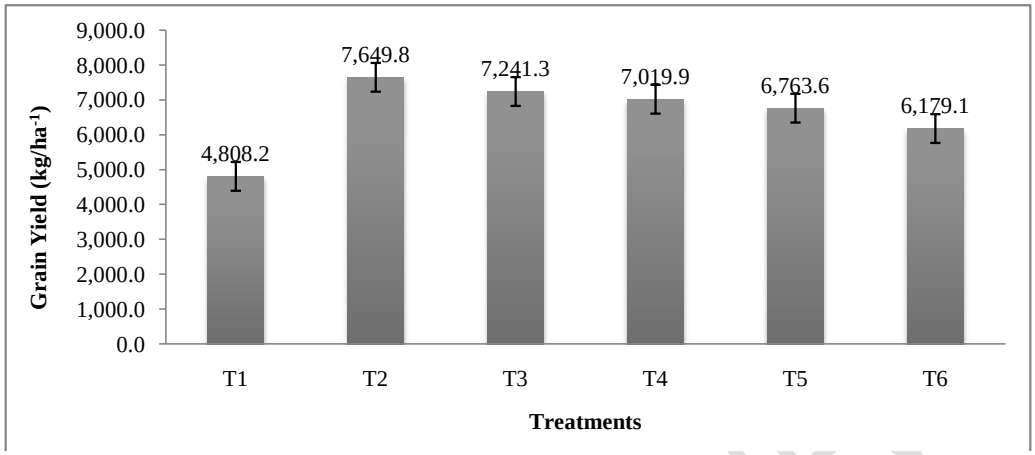

Fig. 3. Grain yield of maize as influenced by different doses of fertilizers and Sahasra Organic Formulations

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Table 5. Economics of maize (*Zea mays* L.) as influenced by different doses of fertilizers and Sahasra organic formulations

Treatment	Gross returns	Net returns	B:C
T_1	79958.975	51308.98	2.8
T_2	123606.491	87116.49	3.4
T_3	117469.759	82466.76	3.4
T_4	113693.399	79477.40	3.3
T_5	109706.733	76627.73	3.3
T_6	100736.175	68811.18	3.2

- **Grain cost Rs 15 /kg ; Stover cost = Rs 1/kg**

3.4 Numberofcobsperplant

Thecob-bearingcapacityisoneofthemostimportantcropyieldcomponents.Moreorless cobs, it is the genetic character of any cultivar butsome improvement can be expected owing to agronomicmanipulations. The number of cobs per plant was not affected significantly by different treatment combinations. Highestnumberofcobsperplantwasobservedwithwith recommended dose of fertilizer treatment. ($T_{2)}$.

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3.5 Cob length (cm)

The highest cob length (20.7 cm) recorded with T_3 (75 % RDF + 25 % SOF) followed by T_2 (100 % RDF) *i.e* 19.8 cm, while the least cob length has been recorded in T_1 control (16.5 cm) treatment. Increase in cob length might be due to adequate and uniform availability of nutrients during the crop growth which resulted inenhancement of the yield attributes Pathak*et al*. (2005) also observed the similar results.

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3.6 Cob girth (cm)

Maximum cob girth (14.5 cm) recorded with T_2 (100 % RDF) followed by T_3 (75 % RDF + 25 % SOF) *i.e* 14.3 cm, while the least cob girth (11.7 cm) was recorded with T_1 (control)

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3.7 Cob weight (g)

The highest cob weight (180.6 g) was recorded with T_3 (75 % RDF + 25 % SOF) followed by T_2 (100 % RDF) (175.9), while the lowest cob weight (128.3 g) noted with T_1 (control).

3.8 Number of kernels cob^{-1}

Higher number of kernels per cob (554.6) were recorded with T_3 (75 % RDF + 25 % SOF) followed by T_2 (100 % RDF) (550.7), while the lowest number of kernels per cob (457.4) were recorded with T_1 (control)

3.9 Grain yield (kg ha^{-1})

Significantly higher grain yield (7649.8 kg ha^{-1}) was recorded with T_2 (100% RDF) which was statistically on par with T_3 (75 % RDF + 25 % SOF) (*i.e* 7241.3 kg ha^{-1}), followed by T_4 which recorded 7,019.9 kg ha^{-1} grain yield closely followed by T_5 and T_6 (6,763.6 and 6,179.1 kg ha^{-1} respectively), while significantly lower grain yield (4808.2 kg ha^{-1}) was recorded with T_1 (control). The maximum grain yield might be attributed due to combined effect of fertilizer along with organic formulations which escalated the availability of nutrients and transport of major nutrients like N, P and K whichalso resulted in increased plant height, no.of leaves and leaf area which in turn lead to increased production and translocation of photosynthates and yield attributes like cob length (cm), cob girth (cm), number of rows cob^{-1} , cob weight (g), grain weight (g). The results are in similar trend with the results of increase of stover yield due to biofertigation of microbes as reported by

Abdelhamid*et al.* (2011), Baral andAdhikari (2013) and Meena*et al.* (2013). Sonawane*et al.* (2009) also reported better grain and dryfodderyieldwithcombinedapplicationofnutrientduetoimprovementinyieldparameterofmaizecrop.Applicationoforganicmanuresbecauseofcombinationwithinorganicfertilizersnotonlyenhancedthenutrientsupplyforhighergrain yield, but also alters the soil physical and chemicalpropertieswhichfavourbettercropgrowthandyield(Prasad*etal*.,2011).

3.10 Stover yield (kg ha^{-1})

Significantly higher stover yield (8859.8 kg ha^{-1}) was recorded with T_2 (100% RDF) which was statistically on par with T_3 (75 % RDF + 25 % SOF) which is (8850.6 kg ha^{-1}), followed by T_4, T_5, T_6 respectively (*i.e* 8394.9, 8252.7, 8049.3 kg ha^{-1}), while the lowest stover yield (7835.6 kg ha^{-1}) was recorded with T_1 (control). The increase in stover yield might be due to combined effect of fertilizer along with organic formulations which enhanced the availability of nutrients like N, P and K, which resulted in increased in plant biometric observations such as plant height, number of leaves and leaf area which in turn lead to higher production and translocation of photosynthates and more dry matter production plant^{-1}. The results are in similar trend were the increase of stover yield due to biofertigation of microbes as reported by Abdelhamid*et al.* (2011) through biofertigation, by seed inoculation in maize by Baral and Adhikari (2013) and Meena*et al.* (2013).Manjhi*et al*. (2014) reported themaximum grain and stover yield under integrated treatment.Kark*ietal*.(2005)alsorecordedsimilarresultinrespectofgrainandstoveryieldofmaize.

3.11 Test weight (g)

The highest test weight (31.8 g) was observed with T_3 (75 % RDF + 25 % SOF) which was on par with T_2 (100% RDF) (*i.e* 31.5 g) followed by T_4, T_5, T_6 respectively (*i.e* 30.4, 30.4, 30.2 g), while the lowest test weight (29.1 g) was recorded with T_1 (control). Due to the application of organic formulations plants received maximum nutrients throughout their growth period and nourished sufficiently,which resulted in maximum 100 kernel weight. Similar findings of more grain weight with imposingintegarated treatment in Maize crops reported by Cheema*et al*. (2010)

3.12 Harvest index (%)

Significantly more harvest index (46.34) noted with T_2 (100% RDF) followed by T_3 (75 % RDF + 25 % SOF which is (45.54), while the lowest harvest index (38.03) observed with T_1 (control).

4. Conclusion:

From this study, it can be concluded that, application of integrated application of (75 % RDF + 25 % Sahasra Organic Formulations) was found to be onpar with 100% recommended dose of fertilizer (T_2) recorded the highest grain yield (7649.8 kg ha^{-1}) and stover yield (8859.8 kg ha^{-1}), gross returns (₹ 123606.5 ha^{-1}), net returns (₹ 87116.49 ha^{-1}) with B:C ratio3.4. and economical with highest net returns (₹82466.8 ha^{-1}) and B:C ratio (3.4) in both the treatments. This clearly indicates the advantage of application of Sahasraorganic nutrients (75 % RDF + 25 % Sahasra Organic Formulations)recording the same yield thus reducing the total fertilizer cost by 25% with similar yield. In addition to this, application of Sahasra organic nutrients enhances the soil health in respect of total nitrogen, phosphorus and potassium content. Significant differences were also recorded in total microbial activity resulting in efficient uptake of nutrients.

So this study clearly indicates that application of recommended dosages of chemical fertilizers incombination with Sahasra organic nutrients gives higher yields and improves the soil health and reduces the cost of cultivation by benefiting the net returns to the farmers.

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References:

Abdelhamid, M.T., Selim, E.M and El-Ghamry, A.M. 2011. Integrated effects of bio and mineral fertilizers and humic substances on growth, yield and nutrient contents of fertigated cowpea (*Vignaunguiculata* L.) grown on sandy soils. *Journal of Agronomy.* 10(1): 34-39.

Ashmead, H. DeWayne.1986. Foliar Feedingof Plants with Amino Acid Chelates. Park Ridge,New jersey USA: Noyes Publications:S662.5-F65.

Baral, B.R and Adhikari, P. 2013. Effect of Azotobacter on growth and yield of maize.SAARC *Journal of Agriculture.*11 (2): 141-147.

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Cheema,M.A.,Farhad,W.,Saleem,M.F.,Khan,H.Z.,Munir,M.A.,Wahid, A., Rasul, F. and Hammad, H.M. 2010.Nitrogenmanagement strategies for sustainable maize production.*Crop Environment.*1:49-52.

Garima and Pant, K.S. 2018.Effect of integrated nutrient manage-ment and tree spacing on production potential of maize(*Zea mays*) under poplar-based agroforestry system. *InternationalJournalofCurrentMicrobiologyandAppliedSciences.*6:2692-2697.

Ghosh,D.,Brahmachari,K.,Brestic,M.,Ondrisik,P.,Hossain, A and Skalicky,M. 2020. Integratedweedandnutrientmanagement improve yield, nutrient uptake and economicsofmaizeintherice maizecroppingsystemofeastern India. *Agronomy.*10:1906-1915.

Goldstein, A.H., Kogers, R.D and Mead, G.1993. Mining by microbe.Nature Biotechnol. 11: 1250-1254.

Karki, T.B., Kumar, A and Gautam, R.C. 2005. Influence of inte-grated nutrient management on growth, yield, content anduptake of nutrient and soil fertility status in maize (*Zeamays*).*IndianJournalofAgriculturalSciences.*75:682-685.

Kim, K.Y., Jordan, D and McDonald, G.A.1997. Solubilization of hydroxyapatite by enterobacteragglomerans, phosphate solubilizing bacteria andmicrobial activity in soil: Effect of carbon sources. *Soil Biology Biochemistry*. 30: 995-1003.

Manjhi, R.P., Yadav, M.S and Thakur, R. 2014. Effect of integratednutrient management on crop productivity and changes insoilfertilityinmaize-wheatcroppingsequence.*IndianJournalofAgronomy*.59:371-376.

Meena, M.D., Tiwari, D.D., Chaudhari, S.K., Biswas, D.R., Narjary, B., Meena, A.L and Meena, R.B. 2013.Effect of biofertilizer and nutrient levels on yield and nutrient uptake by maize (*Zea mays* L.).*Annals of Agri-Bio Research.* 18(2): 176-181**.**

Okada, S.1998.Lactic acid Bacteria fordeveloping a clean environment.Biseibutsu (inJapanese).4: 56-70.

Pathak, S.K., Singh, S.B., Jha, R.N and Sharma, R.P. 2005. Effectof nutrient management on nutrient uptake and changes insoilfertilityinmaize(*Zeamays*)-wheat(*Triticumaestivum*)croppingsystem.*IndianJournalofAgronomy*.50:269-273.

Prasad,J.,Karmakar,S.,Kumar,RandMishra,B.2011.Influenceofintegratednutrientmanagement onyieldandsoilpropertiesinmaize-wheatcroppingsysteminanAlfisolofJharkhand. *Journal of Indian Society of Soil Science*.58:200-204.

Sonawane,D.A.,Gethe,R.M.,Pawar,V.Y.,Jadhav,A.GandWadile,S.C.2009.Performanceofmaize*(Zeamays*L.)underintegratednutrientmanagement.*Bioinfolet*.6:270-280.

Walia, S.S and Kler, D.S. 2010. Effect of organic and inorganicsources of nutrition on growth, macro and micro nutrientuptakeinmaizeundermaize–wheatsequence.*IndianJournalofEcology*.37:27-29.