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Integrated nutrient management on baby corn (*Zea mays* L.): A review

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Abstract
Baby corn, a speciality corn, successful in countries like Thailand and Taiwan has now proven to be a successful venture and a source of foreign earning exchange for India. The baby corn is not different from normal corn, rather these are the immature cobs of normal corn. One Hundred (100) grams of baby corn are rich in 89.1% moisture, 8.2 mg carbohydrate, 1.9 g protein, 0.06 g ash, 0.2 g fat, 28.0 mg calcium, 86.0 mg phosphorus and 11.0 mg ascorbic acid (Thavaprakash, *et al*., 2005). Maximum productivity of baby corn can be achieved or improved through the application of chemical fertilizer but substitution of some portion of chemical fertilizers along with organic manure or biofertilizer will maintain soil health as well as improve economic stability of farmers. Integrated nutrient management (INM), a judicious amalgamation of fertilizers or manures from different sources in order to maintain the environmental sustainability is the need of the hour.

Keywords: Baby corn, nutrient management, FYM, vermicompost

Introduction
Maize (*Zea mays* L.), popularly called queen of cereals is considered as one of the most important world cereals which serves as staple food crop for human being and feed for animals, also used as a source of raw material for the production of oil, protein, starch, food sweeteners and alcoholic beverages as well as fuel source. The cultivation of baby corn was a successful venture in countries like Thailand and Taiwan despite being a recent development in India. Now attention is being given by both scientist and farmers to find out its potentials for obtaining more foreign earning as well as maximum returns to the growers. These are consumed by human beings as a source of vegetable and after harvest the plant can be used as green fodder. Furthermore, the cultivation of baby corn can give double return to the farmer unlike normal grain maize. One hundred grams of baby corn are found to be rich in 89.1% Moisture, 1.9 g Protein, 0.2 g Fat, 0.06 g Ash, 8.2 mg Carbohydrate, 28 mg Calcium, 86 mg Phosphorus and 11 mg Ascorbic Acid (Thavaprakash *et al*., 2005) [34]. The leading exporting countries of baby corn in the world include Thailand, Sri Lanka, Taiwan, China, Zimbabwe, Zambia, South Africa, Nicaragua, Costa Rica and Guatamela. However, the major importers of baby corn in the world are U.K., U.S.A., Malaysia, Japan and Australia. The application of inorganic fertilizers helps in obtaining maximum production of baby corn but it increases the cost of production along with its hazardous effects on environmental health. So judicious uses of nutrients from different source like chemical, organic as well as biofertilisers will maintain the environmental sustainability for generations (Dadarwal *et al*., 2009) [7]. The adoption of INM practices on the field will reduce the production cost thereby increasing the economics of the farmers. It also increases the supply and availability of nutrients to the crop as well as enhances the activity of beneficial soil microorganisms due to availability of more organic matter in soil. In this direction, it is the need of the hour to lay emphasis on application of adequate quantities of plant nutrients, a key aspect of increasing productivity of different crops particularly in intensive agriculture.

Effect of INM on growth parameters of baby corn
Integrated nutrient management (INM) aims to optimize the condition of the soil, with regard to its physical, chemical, biological and hydrological properties, for the purpose of enhancing farm productivity, whilst minimizing land degradation. There is now greater awareness that INM not only provides tangible benefits in terms of higher yields, but also simultaneously conserves the soil resource.

The field level management practices include the use of farmyard manures, natural and mineral fertilizers, soil amendments, crop residues and farm wastes, green manures, cover crops, legumes, intercropping, crop rotations, fallows, irrigation, drainage, plus a variety of other agronomic, vegetative and structural measures designed to conserve both water and soil. The underlying principles on how best to manage soils, nutrients, water, crops and vegetation to improve and sustain soil fertility and land productivity and their processes are derived from the essential soil functions necessary for plant growth.

Indian soils have become deficient not only in major plant nutrients like nitrogen, phosphorus and in some cases, potash but also in secondary nutrients, like sulphur, calcium, and magnesium. Micronutrients such as zinc, boron and to a limited extent iron, manganese, copper and molybdenum have also been reported to be deficient. Deficiency of secondary and micronutrients during the last three decades has grown in both, magnitude and extent because of increased use of high analysis fertilizers, use of high yielding crop varieties and increase in cropping intensity. This has become a major constraint to production and productivity of crops. Thus, there is an urgent need for correction of individual nutrient deficiency and for arresting its further spread through INM approach.

A field study was conducted at Vanavarayar Institute of Agriculture and the result showed that, integrated nutrient management has positive effect on growth parameters of maize such as leaf area and plant height (Kannan *et al*., 2013) [11]. Similarly, a trial conducted at University of Agriculture Faisalabad, Pakistan, in their Agronomic trial field and the result showed that the combining ability of poultry manure with single super phosphate result in positive increase in growth parameter of maize such as leaf area index and crop growth rate (Ali *et al*., 2012) [1]. It was also reported that, the integrated nutrient management has significant effect on growth parameters of maize crop, which was found in a field trial conducted at ICAR research field Umiam, Meghalaya (Panwar, 2008) [22]. Kumar *et al*. (2008) [14] reported that application of 120 kg N/ha through Urea along with 30 kg N/ha through poultry manure resulted in significance increase in growth attributing parameters in maize crop. Maize crop vigor was observed to be better under integrated nutrient management than sole application of FYM or Urea in a field trial conducted at Makawanpur District of Nepal (Chapagain, 2009, 2010) [6]. Similarly, Mahajan *et al*. (2007) [17] conducting a field trial at Kangra district of Himachal Pradesh reported that the integrated used of both organic and inorganic manure has positive effect on the total productivity of maize crop than sole used of mineral fertilizer. Saha and Mondal (2006) [25] in a field experiment at Nadia, WB on influence of integrated plant nutrient supply on baby corn revealed that plant height varied significantly due to INM treatments. The tallest plant was recorded with the application of pelleted form of organic matter (Biomax) along with 75% RDF followed by treatments receiving neem seed powder and FYM along with 75% RDF compared to 100% RDF. Rasool *et al*. (2015) [23] from a field experiment found that that application of 75% (NPK) + FYM (4.5 t/ha) + Biofertilizer (*Azotobacter* + Phosphate solubilizing bacteria (PSB) significantly increased the number of days taken to tasseling, silking and milky stages and various other growth characters viz., plant height, leaf area index, dry matter, crop growth rate and relative growth rate. A field experiment conducted by Dadarwal *et al*. (2009) [7] at Udaipur, Rajasthan in evaluating the effect of integrated nutrient management on baby corn showed that maximum plant height and dry matter accumulation were recorded under 75% NPK+2.25 t vermicompost/ha along with biofertilizer over rest of treatments. The field experiment conducted by Meena *et al*. (2012) [19] at IARI to study the influence of nutrient sources on growth, productivity and economics of baby corn -potato-mungbean cropping system revealed that N_{90} P_{20} K_{25} + bio-compost equivalent to 30 kg N/ha recorded highest growth parameters like plant height (151.8cm), LAI (4.02) and dry matter (67.7 g/plant) An experiment was conducted by Keerthi *et al*. (2013) [12] at Naira, Andhra Pradesh, to study the effect of nutrient management practice on sweet corn. Application of 180-75-60 kg NPK/ha + vermiwash at 20, 35, and 50 DAS recorded the highest growth parameters, which was at par with 180-75-60 kg NPK/ha + vermicompost. Thavaprakash *et al.* (2005) [34] in a field experiment at Coimbatore observed that integrated nutrient management practices exerted positive influence on growth characters of baby corn. Combined application of 50% NPK with poultry manure and bio fertilizers (*Azospirillum* + phosphobacteria) registered taller plants (183.1cm), higher LAI (3.47) and dry matter per plant (7543 kg/ha).

Effect of INM on yield attributing characters and yield baby corn

Rakib *et al.* (2011) in a study on effect of integrated nutrient management on baby corn at Sriniketan concluded that cob length was the highest with application of 75% RDF + 25% N applied through FYM which was equally effective as 100% RDF given through inorganic source. Similar results were earlier confirmed by Kumar *et al*. (2005). Cob girth was the highest with the application of 75% RDF + 25% N (FYM) which indicated integrated application of nutrients resulted in better performance regarding girth of baby corn. Similar results were obtained by Thavaprakash *et al*. (2005) [34] and Dhaliwal *et al*. (2007). Number of baby corns/ha were the highest with application of 75% RD + 25% N (FYM) which was equally effective as 100% RD given through inorganic source. Similar findings were reported by earlier workers (Kumar *et al*., 2005; Ali and Awan, 2009). Maximum yield of husked baby corn was recorded with application of 75% RDF+ 25% N (FYM), which was significantly greater than all other treatments. Similar results were also obtained by Ashok *et al*. (2009) [3]. Siddeswaran and Shanmugam (2013) [29] in afield experiment at TNAU, Coimbatore evaluated the performance of different organic farming packages. The results revealed that the combination of both the organics and inorganics in equal proportion of N equivalent resulted in higher baby corn yield. Lone *et al*. (2013) [16] from a field experiment at Kashmir observed that application of FYM @ 6t/ha in combination with 150% recommended dose of fertilizer (225N: $90P_2O_5$: 60 K_2O kg/ha) recorded maximum cob yield (without husk) of 20.60 q/ha associated with maximum number of cobs/plot (326) and green fodder yield. It was revealed from both years of experimentation in the field that the integration of 75% (NPK) + FYM @4.5 t/ha + mixed biofertilizer (phosphate solubilizing bacteria (PSB) + *Azotobacter*) proved to be significantly superior to rest of the treatments including unfertilized control in increasing cob yield with and without husk, fodder yield and green biomass yield (Rasool *et al*., 2015) [23] Dutta *et al.* (2013) found application of FYM along with recommended doses of fertilizers resulted in the highest yield of wheat grain and straw in acid *alfisol* of western Himalayas of India. This

increase may be due to addition of FYM which besides supplying all the essential nutrients might have also improved the physico-chemical properties of the soil. In a field experiment carried out on sandy loam soils of Varanasi, UP by Singh *et al*. (2010) [30] observed higher values of yield attributes *viz*., baby cob weight, baby corn weight, number of cobs/plant, baby corn girth and baby corn yield with application of 100% N as fertilizer which remained at par with application of 75% N through fertilizer and 25% N through organic mode. Kumar *et al*. (2009) [13] in a field experiment on influence of Integrated nitrogen management on yield, nitrogen uptake, soil fertility status and economics of baby corn at Tirupati revealed that application of 100 per cent N through fertilizer has resulted in baby corn yield (1568 kg/ha) which was however at par with 75 per cent N through fertilizer along with 25% N through poultry manure or sheep manure or farm yard manure. At Chidambaram, Tamil Nadu, the field experiment on yield and nutrient uptake of baby corn revealed that recommended NPK + vermicompost @ 5t/ha recorded higher baby corn yield (7195 kg/ha) than recommended NPK alone (Aravinth *et al*., 2011) [2]. Micronutrients are required in small amounts and they affect directly or indirectly photosynthesis, vital processes in plant such as the respiration, protein synthesis, reproduction phase. A field experiment conducted by Ashoka *et al*. (2008) [4] at Raichur, Karnataka showed that application of RDF (150:75:40 kg N, P_2O_5, K_2O/ha) + 25 kg Zn SO_4/ha+ 10 kg Fe SO_4/ha+35 kg vermicompost recorded significantly higher yield and yield components viz. ear length (7.40 cm), ear girth (4.99 cm) ear weight (17.40g), yield (64.43q/ha) and green fodder yield (232.33 q/ha). Sharma and Banik (2014) [27] in a study on *Arbuscular mycorrhiza*, *Azospirillum* and chemical fertilizer application to baby corn at Indian Statistical Institute, Kolkata revealed that 100% RDF (150:60:60=N: P_2O_5: K_2O kg/ha) + AM + *Azospirillum* produced maximum baby cob and green fodder yield. A field experiment conducted by Dadarwal *et al*. (2009) [7] at Udaipur, Rajasthan to evaluate effect of integrated nutrient management on baby corn showed that significantly the highest baby corn and green fodder yield were recorded under 75% NPK+ vermicompost@ 2.25 t/ha along with biofertilizer. An experiment conducted by Keerthi *et al.* (2013) [12] at Naira, Andhra Pradesh to study the effect of nutrient management practice on sweet corn ascertained the application of 180-75-60 kg NPK/ha + vermin wash at 20, 35, and 50 DAS recorded the highest yield attributes and cob yield which was at par with 180-75-60 kg NPK/ha + vermicompost. Integrated nutrient management treatments exhibited their superiority at the enhanced levels of fertilization over the same levels under chemical sources in enhancing green cob yield. The field experiment conducted by Meena *et al*. (2012) [19] at IARI to study the influence of nutrient sources on growth, productivity and economics of baby corn-potato-mungbean cropping system revealed that N_{90} P_{20} K_{25} + bio-compost equivalent to 30 kg N/ha recorded highest yield parameters like longer, thicker and heavier cobs, babycorn yield and green forage yield which remained at par with $N_{120}P_{26}K_{33}$. Thavaprakash and Velayudham (2011) [32] in afield experiment at Coimbatore in sandy clay loam soil revealed that integrative use of half of NPK with either poultry manure or goat manure in addition to Biofertilizers (*Azospirillum* and phosphobacteria) recorded significantly higher baby corn yield. Combined application of inorganic (50% NPK), poultry manure and bio fertilizers (*Azospirillum* + phosphobacteria) produced higher cob yield than FYM incorporated with inorganic and biofertilizers and inorganic fertilizers alone. Thavaprakash *et al.* (2005) [34] in a field experiment at Coimbatore observed that integrated nutrient management exerted positive influence on yield attributes of baby corn. Combined application of 50% NPK with poultry manure and bio fertilizers (*Azospirillum* + phosphobacteria) registered longer cobs (24cm) and corns (10.9cm), thicker cobs (3.80 and 3.65cm) and corns (1.74cm) and heavier cobs (50g) and corns (11.4g). INM treatments had synergistic effect on green cob and fodder yield of baby corn. Combined application of 50% NPK with poultry manure and bio fertilizers (*Azospirillum* + phosphobacteria) produced higher cob yield (7707 kg/ha) when compared to FYM incorporated with inorganic and Biofertilizers (7012 kg/ha). Similar response was also observed in case of fodder yield. Thavaprakash *et al*. (2008) [35] in afield experiment at Coimbatore in sandy clay loam soil observed combined application of inorganic and biofertilisers (*Azospirillum* + phosphobacteria) along with either poultry manure or goat manure produced higher cob yield (7668 kg/ha) and corn yield (5608 kg/ha) as compared with FYM incorporated with inorganic and biofertilizers and inorganic fertilizers alone. Similar trend was also observed in case of green fodder yield. Field experiment at Nadia, WB on influence of integrated plant nutrient supply on baby corn revealed that the highest fresh weight of individual green cob and baby corn weight was recorded with the application of pelleted form of organic manure (biomax) along with 75% RDF. Significant increase in baby corn/plant, weight of green cob and baby corn were also found in the treatments of integrated supply of nutrients from organic manure (biomax, FYM, neem seed powder) along with 75% inorganic fertilizer. Significantly the highest yield of baby corn (with husk, without husk and standard yield) was recorded in the treatment receiving pelleted form of organic matter (Biomax) along with 75% RDF compared with the control. Same trend was also observed in case of green fodder yield (Saha and Mondal, 2006) [25]. Panwar (2008) [22] concluded from a field trial at ICAR research complex, Umiam, Meghalaya that the yield parameters of maize showed significant increase with combined application of 50 per cent N of RDF from FYM and recommended doses of NPK. Furthermore Bhagade *et al*. (2008) [5] from a field trial conducted at Konkan region of India suggested that substitution of 25 per cent recommended doses of fertilizer through FYM positively yielded better green fodder production of maize. A field trial from central institute of temperate horticulture regional station, Uttarakhand, India showed that the grain yield of maize was significantly increased as a result of the combined application of different sources of nutrients to the maize plant (Ghaffari *et al.*, 2011) [10]. Kannan *et al*. (2013) [11] in a research trial conducted at Institute of Agriculture, Vanavarayar reported that integrated nutrient management provided the superior result on yield characters of maize like 100 seed weight and number of grain per cob and yield of 4112 Kg/ha due to combined effect of vermicompost and recommended dose of NPK. Agronomic field trial conducted at the University of Agriculture, Faisalabad, Pakistan showed significant increase in yield attribute of 1000 seed weight of maize due to integration of both organic and inorganic manure as reported by Ali *et al.* (2012) [1]. Ravi *et al*. (2012) [22] confirmed from the research trial conducted at Agricultural Research Station, Arabhavi of Karnataka that the use of 75 per cent RDF with other organic and bio-fertilizer significantly increased the grain yield of quality protein maize.

Effect of INM on nutrient uptake of baby corn

Aravinth *et al*. (2011) [2] pointed out from a field experiment conducted at Chidambaram, Tamil Nadu on yield and nutrient uptake of baby corn that the highest nutrient removal of 164.5 kg N, 22.9 Kg P and 184.5kg K/ha was recorded in combined application of recommended NPK+ vermicompost @ 5t/ha, which was comparable with recommended NPK + FYM @ 12.5 t/ha. Results of field study done on arbuscular mycorrhiza (AM), *Azospirillum* and chemical fertilizer application to baby corn as reported from Indian Statistical Institute, Kolkata, West Bengal revealed that 100% RDF (150:60:60:N:P_2O_5:K_2O kg ha^{-1}) + AM + *Azospirillum* recorded maximum nutrient uptake. Residual soil fertility in terms of NPK was maximum with the same treatment (Sharma and Banik, 2014) [27]. Singh *et al*. (2010) [30] in afield experiment performed at Varansi, Uttar Pradesh observed nutrient uptake was influenced significantly due to fertility levels and sources of N. Significantly higher nutrient uptake was recorded with the application of 100% N through inorganic source of fertilizer over integrated nutrient management practices. A field experiment conducted by Dadarwal *et al.* (2009) [7] at Udaipur, Rajasthan in evaluating the effect of integrated nutrient management on baby corn showed that application of 75% NPK+2.25 tvermicompost/ha along with biofertilizer significantly increased the available N,P and K status of soil after harvest of baby corn. From an experiment conducted on the effect of nutrient management practices on sweet corn at Naira, Andhra Pradesh, Keerthi *et al*. (2013) [12] reported that application of 180-75-60 kg NPK/ha + vermin wash at 20,35 and 50 DAS recorded the highest values for NPK uptake which was at par with 180-75-60 kg NPK/ha + vermicompost. Higher values for the uptake of NPK by maize with enhanced levels of nutrient supply was also evidenced by earlier researchers (Sunitha and Maheswara Reddy, 2012) [31]. Significantly higher values for post-harvest soil available N, P_2O_5 and K_2O were obtained with the application of the highest dose of 180-75-60 kg NPK/ha + 30 kg N/hathrough vermin compost which was comparable with 180-75-60 kg NPK/ha + vermiwash at 20, 35 and 50 DAS as reported by Keerthi *et al*. (2013) [12]. Kumar *et al.* (2009) [13] investigating the influence of integrated nitrogen management on yield, nitrogen uptake, soil fertility status and economics of baby corn at Tirupati, Andhra Pradesh recorded the highest N uptake in baby corn with application of 100 per cent N in form of inorganic fertilizer which remained at par with application of 75 per cent N through inorganic source in combination of 25% N with poultry manure or sheep manure or farm yard manure. In a study on effect of integrated nutrient management in baby corn at Sriniketan, West Bengal, Rakib *et al*. (2011) concluded that the highest gross return (Rs.62500/ha), net return (Rs.47682/ha) and benefit: cost ratio (3.21) were registered from application of 75% RDF + 25% N (FYM) closely followed by 75% RD + 25% N (FYM) + *Azotobacter* and 100% RD + *Azotobacte*r. Similar results were reported by and Saha and Mondal (2006) [25]. Effect of INM studied in a field experiment performed at Coimbatore, Tamil Nadu revealed that highest nutrient removal was noted due to the combined effect of inorganic (50% NPK), poultry manure and bio fertilizers (*Azospirillum* + phosphobacteria) which was comparable with 50% NPK+ goat manure + *Azospirillum* + phosphobacteria (Thavaprakash and Velayudham, 2007) [35]. Similar results were reported earlier by Thavaprakash *et al*. (2005) [34]. Saha and Mondal (2006) [25] recorded the highest nutrient uptake (N, P, K) with the application of pelleted form of organic manure (biomax) along with 75% RDF from a field experiment at Nadia, WB on the influence of integrated plant nutrient supply on baby corn. They also observed an increase of 26 kg N/hain soil fertility after 2 years with the addition of 75% RDF + pelleted form of organic manure. Maximum increase in available P (34.17%) was recorded with the treatment receiving 75% RDF + organic manure rich with humus. Increase in available K was maximum (5.72%) under the treatment receiving 75% RDF+ FYM. Organic carbon content was improved due to application of any source of organic manure. Highest value for organic carbon was obtained under the treatment receiving 75% RDF + crop residue. Kannan *et al*. (2013) [11] observed from a field trial done on integrated nutrient management significantly influenced the maximum increase in organic carbon as a result of integrated used of vermicompost and recommended dose of NPK. The results of an Agronomic field trial conducted at University of Agriculture Faisalabad, Pakistan showed the integrated nutrient management was one of the good approach for nutrients management in the environmental balance (Ali *et al*., 2012) [1]. Ghaffari *et al*. (2011) [10] reported that the nutrients use efficiency was improved up to 11.5% due to combined effect of recommended dose of NPK along with single spray of multinutrients. Application of 180 kg N + 38.7 kg P_2O_5 + 74.7Kg K_2O/ha and 50% N supplied through FYM resulted in significant increase in available NPK in soil after harvesting baby corn (Singh *et al*., 2010) [30]. Sarwar *et al*. (2012) [26] reported that both organic matter content and nutrients uptake in the soil was increased if 25 or 50 per cent of N requirement was replaced in organic form of FYM. Rao *et al*. (2010) [21] also suggested that the integrated application of nutrients in maize grown under rainfed maintained and sustained the soil resources. The nutrients (N, P and K) uptake was found to be significantly higher due to integration of 50% RDF along with either poultry manure or FYM than sole application of 100% RDF. In addition to release of plant nutrients from organic matter, the organic acid produce during decomposition process also released the native nutrients on soil and increased their availability to plant (Thavaprakash, *et al*., 2008 and Shilpashree *et al*., 2012) [35, 28]. Ebrahimpour *et al*. (2011) [9] reported that significance increased of soil nutrients were observed due to use of biofertilizer and they concluded that non-chemical sources of crop nutrition provide a reliable alternative to chemical fertilization in organic crop production. Dadarwal *et al*. (2009) [7] reported that continuous application of FYM enhances the availability of NPK status of soil after harvest of baby corn.

Effect of INM on Economics of baby corn

Sharma and Banik (2014) [27] in a study on *Arbuscular Mycorrhiza, Azospirillum* and chemical fertilizer application to baby corn at Indian Statistical Institute, Kolkata revealed that benefit: cost ratio were higher with 50% RDF(150:60:60= N:P_2O_5:K_2O kg/ha) + AM + *Azospirillum*. Siddeswaran and Shanmugam (2013) [29] in a field experiment at TNAU, Coimbatore evaluated the performance of different organic farming packages. The results revealed that the combination of both the organic and inorganic (50% each) resulted in higher net return and B: C ratio due to less cost involved in nutrient application as compared with different organic farming packages. Saha and Mondal (2006) [25] in a field experiment at Nadia, WB on influence of integrated plant nutrient supply on baby corn revealed that net return and benefit: cost ratio of baby corn increased with the application of 75% RDF along with each of pelleted form of organic

manure, neem seed powder and FYM over 100% RDF. The results of a field experiment on influence of integrated nitrogen management on yield, nitrogen uptake, soil fertility status and economics of baby corn at Tirupati revealed that application of 100 per cent N through fertilizer recorded highest net return and benefit: cost ratio in baby corn which was at par with 75 per cent N through fertilizer along with 25% N through poultry manure or sheep manure or farm yard manure (Kumar *et al.,* 2009) [13]. A field experiment conducted by Dadarwal *et al.* (2009) [7] at Udaipur, Rajasthan to evaluate effect of integrated nutrient management on baby corn showed that significantly higher net return (Rs.26815/ha) and benefit: cost (2.83:1) were recorded under 75% NPK+ 2.25 t vermin compost/ha along with biofertilizer. Lone *et al.* (2013) [16] from a field experiment at Kashmir observed that application of farm yard manure (FYM) at 6 t/ha in combination with 150% recommended dose of fertilizer (90N:60P_2O_5: 40 K_2O kg/ha) recorded maximum B: C ratio of 1:1.59.

Conclusion

Thus, it can be concluded that the integration of different sources of nutrients either from chemical, organic or biofertilizers recorded higher growth parameters, yield attributes and yield rather than sole use of either chemical fertilizers or organic manures. INM maintains and sustains soil health as well as improves the economic stability of the farmers.

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