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INTEGRATED NUTRIENT MANAGEMENT AND ITS COMPONENTS IN SOLANACEOUS VEGETABLE PRODUCTION—A REVIEW

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ABSTRACT

Soil fertility maintenance requires a balanced application of inorganic and organic nutrient sources. Sustainable agricultural productivity might be achieved through a wise use of integrated nutrient management. INM system is to manage and sustain the agricultural productivity and improve the farmer's profitability through the judicious and efficient use of chemical fertilizers, organic manures, green manures, and compost including vermicompost, crop residues and bio-fertilizers. However, this does not mean adding everything everywhere; rather, a well-considered practical and efficient blend of diverse nutrient sources is required which can produce desired yields and maintain soil health on long-term basis. INM system helps to restore and sustain crop productivity, and also assists in inspection the emerging micronutrient deficiencies. Further, it brings economy and efficiency in the use offertilizers. Research works on INM system for solanaceous vegetables crops is scanty. This paper has reviewed the research work carried out by various scientists in India and abroad. The review deals with the effect of integrated nutrient management and its components in solanaceous vegetable production

Key words : INM, organic manures, composts, vermicompost, crop residues, green manures, bio fertilizers, chemical fertilizers, economy and yield.

India accounts for 2.2% of the global land and 16% of the world's population. The country's population has crossed the one-billion mark in 2001. While the population is likely to further increase at an alarming rate and, side by side, as the land for cultivation of crops will decrease tremendously in the following decades, it will result in an increased demand for food, fodder, shelter, energy, employment, etc. The long-term fertilizer experiments have shown that continuous application of suboptimal doses of chemical fertilizers alone to soil has resulted in the deterioration of soil health, thereby culminating in environmental pollution and stagnation in crop productivity. Solanaceous vegetables are one of the most popular and commercially important vegetable crops of India. With the increase in population, the demand for these vegetables rapidly increased. Through India has emerged as second largest vegetable producing country in the world, but the present level of production is not able to make pace with the increasing population. Only one source of nutrients like chemical fertilizers, organic manures and bio fertilizers cannot improve the production or maintain the production sustainability and soil health. Hence, integrated use of organic manures with optimal levels of NPK fertilizer is the need of the hour, as it will not only improve the nutrient status and soil health, but also prove to be a boon in stabilizing the crop yields over a period of time. Integrated nutrient management is one of the most important component of modern production technology to sustain the vegetable production and soil fertility in the future soastoachieveandtosustaintheoptimumyield and to improve or to maintain the soil's physical, biological and chemical properties.. Plant nutrients can be supplied from different sources i.e., organic manures, composts/vermicompost, crop residues, green manures, biofertilizers and chemical fertilizers. Such a crop nutrition package has to be technically sound, economically attractive, practically feasible and environmentally safe (Hedge and Rudragouda, 2003).

The combined application of organic and inorganic sources of plant nutrients not only enhance the vegetable production, profitability but at the same time helps in maintaining the soilfertility. From nutrition point of view the role of organic manures is very meagre; however, its value lies more in it saction as a soil ameliorate, corrective for physical conditions and a parameter of biological activity to enhance soil productivity. Use of organic manure is inevitable for sustained agricultural production. The different components of INM possess great diversity in terms of

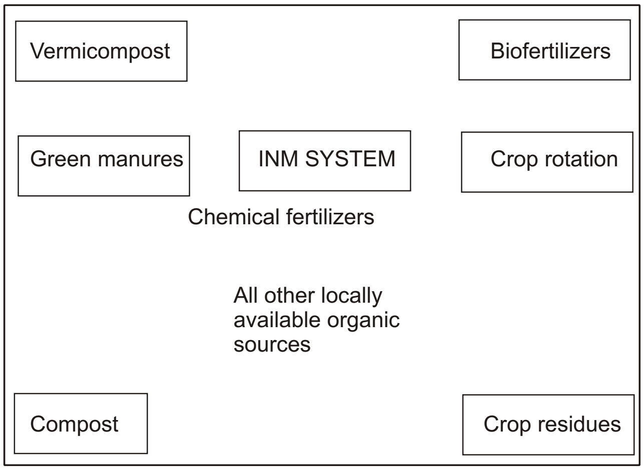

Fig.-1 : Flow chart showing the different components of INM system.

physical and chemical properties and the nutrient release patterns (Pasricha *et al.*,1996). Keeping in view the present fertility status of vegetable growing areas, decline in the yield and quality of vegetables, concerns on nutritional and health security, environmental hazards, it is desirable for making massive efforts to adopt organics as a vital source of plant nutrients along with inorganic ones as their sole applications are in no way, a solution to sustain soil fertility and crop productivity. Therelevantandimportantpublishedwork available on solanaceous vegetables has been reviewedandpresentedhereunderthefollowing heads.

Objectives of INM

To reduce the dependence on chemical fertilizers.

To maintain productivity on sustainable basis without affecting soil health.

To conserve locally available resources & utilize them judiciously.

To reduce the gap between nutrients used & nutrients harvested by the crop.

To improve physical, chemical & biological properties of soil.

To make soil healthy by providing balanced nutrients through different nutrient sources.

To overcome or reduce the ill effects of continuous use of only inorganic chemical fertilizers.

To improve economical status of farmers.

To increase the fertilizer use efficiency (FUE).

Components of INM (Inorganic sources)

Major nutrients : Vegetables need bulk of major nutrients. Requirement of nitrogen in most of the vegetable crops is quite high and brings a linear increase in yield. Increase in yield due to N fertilization could be attributed to luxuriant growth increased photosynthesis and better translocation of photosynthates. Requirement of phosphorus is not too high but is essential for plant health and is reported to have significant effect on the yield of vegetables. Potassium is required in higher quantity to improve the quality and shelf life of vegetables (root crops). Improper and imbalanced use of chemical fertilizers is hazardous with respect to overall soil health, yield and quality of vegetables. Sustainable yields can be harvested only if they are used in combination with other sources of plant nutrients like organic manures, compost and bio-fertilizers.

Secondary and micro nutrients : Adoption of improved technology in vegetable in vegetable production had decreased the level of secondary and micronutrients in most of the Indian soils, which is evident by response to addition of these nutrients. Among secondary nutrients, requirement of sulphur is at par with that of phosphorus. Micronutrients along with secondary nutrients are known to improve the yield and quality of vegetables. So their application becomes indispensable for sustainable vegetable production. For optimizing plant nutrient efficiency the time and method of application plays a key role. Nitrogenous fertilizers should be applied in split doses, while phosphatic and potassic fertilizers as basal treatments. Organic manures/composts should be well decomposed and applied at least 20-25 days prior to planting. Microbial inoculants should be applied 24-48 hours after chemical fertilizer application. Sustainability in vegetables also depends upon source of nutrients. Urea is an efficient source of N. Water soluble phosphatic fertilizers are more suitable for direct application in vegetable crops. K_2SO_4 is considered better option for K fertilization. As for organic sources are concerned their nutrient content depends on sources from which they are prepared. Poultry manure proved superior to sheep and farm yard manure

Organics Sources

Organic manures : Organic manures include farm yard manure, compost, vermicompost, poultry manure, sheep manure, night soil, oil cakes and excrete of other animals. Organic manures is the major and commonly

Table-1 : Effect of chemical fertilizers, organics and their integration on the yield/quality of vegetable crops.

Crop	Yield (q/ha)			Source
	Chemical fertilizers	Organics	Integration of chemical fertilizers with organics	
Brinjal	378.00	351.50	454.6	Jose *et al.,* (1988)
Okra	108.37	101.93	164.3	Abusaleha and Shamugavelu (1988)
Chilli	61.12	63.93	70.75	Malewar *et al.,* (1998)
Tomato	276.20	196.30	277.0	Bhardwaj *et al.,* (2000)
Brinjal	96.40	95.70	96.20	Rao *et al.,* (2001)
Capsicum	248.66	193.95	296.3	Magray *et al.,* (2002)
Tomato	385.77	291.69	510.4	Rafi *et al.,* (2002)
Cabbage	332.96	319.29	39.95	Chattoo *et al.*, (2003)
Okra	63.74	56.35	67.21	Ray *et al.*, (2005)
Cabbage	372.40	357.00	370.0	Chattoo *et al.,* (2006)
Okra	259.24	211.01	272.1	Chattoo (2006)
Capsicum	430.48	-	66.39	Malik (2008)

Table-2 : Effect of organic manures on quality of vegetables.

Organic and inorganic sources of plant nutrients enhanced fruit quality in Okra	Abusaleha and Shamugavelu, 1988
Poultry manure application enhanced dry matter content and uptake of nutrients in Brinjal cv. MDU-1	Jose *et al.,* 1988
Cattle, sheep and poultry manures proved effective in controlling the root knot nematode in Okra	Montasser, 1990
Application of linseed cake + fertilizer recorded lowest galls/plant in tomato	Shah *et al.,* 1992
Application of FYM, PM, SM and cakes significantly decreased nematode development in Okra	Khan, 1994
Organically grown tomato has lower dietary fiber content, higher sugar and malic acid content	Lucarini *et al.,* 1999
Organic manures depicted higher dry mater and ascorbic acid content and lower calcium content in cabbage	Fiedorow, Magroy, 2002
Organic manures enhanced P and Ca content in tomato fruits	Colla *et al.,* 2002
Organic and inorganic sources exhibited sustainability in quality of cabbage	Chattoo *et al.,* 2003
Combined application of FYM + 50 RFD improved quality in tomato	Narayan *et al.,* 2004
Organics and their integration with in-organics improved fruit and seed yield in Okra	Chattoo (2006)
Congugation of organic manures and chemical fertilizers exhibited a positive influence on quality parameters of Capsicum	Malik (2008)

used organic nutrient component in INM. The nutrient value of organic manures is not comparable to inorganic fertilizers. However, poultry manure/ vermicompost/oil cakes are comparatively richer sources of nutrients and all of them play a vital role in maintaining soil fertility though their effects on physico-chemical properties of soil (Tandon, 1992) Importance of organic manures in vegetable production is an established fact. Organic manures release nutrients decomposition. Organic manures contain small percentage of nutrients and are applied in large quantities .The influence of INM system on growth, yield and quality of vegetable crops is presented in Table-1 and 2.

Compost : Compost are rich sources of essential plant nutrients. Besides, nutritional richness, composts are known to improve the physical, chemical and biological properties of the soil. Composts are also helpful in reducing the outlay on fertilizers Compost is an amorphous brown to dark humified material produced as a result of microbial decomposition of organic wastes collected from urban and rural wastes. In addition to microbial decomposition, machines are also used to produce compost, commonly known as mechanical compost. Soil invertebrates (earth worms) are also used effectively for recycling of non-toxic/degradable organic wastes to the soil. Culturing of earth worms is referred as vermiculture and the recycled produce, which is granular is referred as vermicompost.Composts are also known to provide additional benefits like suppression of soil borne plant

Table-3 : Influences of compost, vermicompost either alone or in combination with inorganic fertilizers on vegetable crop improvement.

Compost from kitchen wastes, yard wastes and FYM	Improved yield, quality and storage performance of cabbage, carrot, tomato and potato resulted in superior sensory quality of tomato	Vogtmann et al., 1993
Vermicompost	Suppressed the development of diseases in tomatoes and cabbage, thus can be used as a bio-pesticide	Szczech and Brezeski., 1994
Straw and cattle manure compost	Increased total carbon content of soil	—-do—-
Cattle manure compost	Reduced nutrient leaching	—-do—-
Coffee pulp compost	Reduced the reproduction of M. javaricain tomato	Zambolim., 1996
Vermicompost + DOS + 75% NPK dose (digested organicsupplement)	Recorded highest TSS and ascorbic acid content in cabbage	Mahendran and Kumar.,1997
Compost from municipal solid waste	Increased water and fertilizer conservation in sandy soil	Qzores Hampton et al., 1998
Sea wood compost	Increased growth rate, protein lipids and moisture content of vegetable	Zahid., 1999
Vermicompost 12 t/ha + 100%RFD	Recorded highest yield of 5663 kg/ha in Okra Reduced significantly the cost of production	Ushakumari et al., 1999
Vermicompost	Was found effective to inhibit infections by Oxysporum f. sp. Lycopersici (causing Fusarium wilt) in tomato plants	Szczech., 1999
Vermosole (Vermicompost extract)	Increase tomato yield by 7.3%, decreased nitrate content of fruits by 15%	Lozek and Gracova, 1999
Compost pure or N enriched compost MSWC (Municipal solid waste compost)	Enhanced soil organic matter, total N& K. Reduced heavy metal content in leaves	Dugoni and Berolasi, 2000
Compost from cucumber plant wastes	Increased the cucumber yield by 15% over control	Abon Hadid et al., 2001
Compost from chicken manure	Increased the cucumber yield by 34% over control	—-do—-
Vermicompost + fertilizer	Recorded larger number of fruits higher level of vit C and sugar in tomato cv. Sunny	Premuzic et al., 2001
Vermicompost + fertilizer	Depicted significant effect on root shoot growth, fruit weight and number of tomatoes	Samawat et al., 2001
Compost + organic manures 22 t/ha + 45 t/ha	Increased available and dissolved organic carbon to un-amended soils	Ercih et al., 2002
Compost + organic manures 22 t/ha + 45 t/ha	Increased available and dissolved organic carbon to un-amended soils	Ercih et al., 2002
Vermicompost + inorganic fertilizer (50% PK) (50% N+K)	Recorded a tuber yield of 308.21 q/ha as compared to RFD 353.31 q/ha in potato	Upadhayay et al., 2003
Vermicompost	Sole application of Vermicompost registered higher fruit yield in Okra as compared to the yield recorded with sole applications of Farm Yard Manure, Sheep manure and bio-fertilizers	Chattoo (2006)
Vermicompost + Chemical fertilizer (50 : 50)	Recorded a fruit yield of 257.76 q/ha which was statistically at par with the yield 259.08 q/ha recorded with RFD, besides recording an improvement in quality attributes of Okra	Chattoo (2006)

Table-4 : Response of vegetable crops to *Azotobacter* and *Azospirillum* inoculation.

Biofertilizer	Crop	Increase in yield (%)	Nitrogen economy (%)	Source
Azotobacter	Tomato	13.60	50	Kumahaswamy (1990)
	Brinjal	3.5	25	Kamali *et al.,* (2002)
	Cabbage	8.60	25	Bhat (2003) M.Sc. thesis, SKUAST (K)
	Okra	9.00	25	Subbiah (1991)
	Cabbage	7.00	25	Jeeva Jothi *et al.,* (1993)
	Chilli	26.70	25	Paramaguru and Natrajan (1993)
	Chilli	15.10	25	Deva *et al.,* (1996)
	Cabbage	11.87	25	Verma *et al.,* (1997)
	Onion	7.74	25	Rather (1997) M. Sc. Thesis, SKUAST-K
	Onion	9.60	25	Thiiackavathy and Ramaswamy (1999)
	Brinjal	3.2	25	Kamali *et al.,* (2002)
	Capsicum	9.98	25	Anonymous (2002)
	Onion	21.68	25	Anonymous (2002)
	Capsicum	2.67	25	Chattoo *et al.,* (2003)
	Cabbage	9.53	20	Bhat *et al.,* (2007)
Azospirillum + PSB	Okra	34.76	-	Chattoo (2006)

Table-5 : Response of vegetable crops to PSM and VAM inoculation.

Biofertilizer	Crop	Increase in yield (%)	Phosphorous economy (%)	Source
PSM and VAM	Tomato	14.20	—	Mohandas (1987)
	Onion	4.70	25	Gurubatham *et al.,* (1989)
	Chilli	14.20	—	Biswas *et al.,* (1994)
	Potato	20.00	—	Biswas *et al.,* (1994)
	Pumpkin	51.00	25	Karauthamani *et al.,* (1995)
	VAM	—	—	—

pathogens and biological weed control. The beneficial effects of compost on yield and quality of vegetables has been reported by a number of research workers (Table-3).

Biofertilizers : Biofertilizer is a substance which contains living microorganisms such as nitrogen fixer or phosphorus solubilizer which, when applied to seed, plant surfaces, or soil, colonizes the rhizosphere or the interior of the plant and promotes growth by increasing the supply or availability of primary nutrients to the host plant. Biofertilizers play a significant role in improving soil fertility and plant growthby fixing atmospheric nitrogen either symbiotically or freely, solubilizing insoluble phosphates into soluble phosphates thereby increasing availability of phosphorus and secreting growth promoting substances for better plant growth. Biofertilizers include *Rhizobium* (Symbiotic nitrogen fixer), *Azotobactor* and Azospirrilium (Non symbiotic nitrogen fixer) *Pseudomonas, Phosphobacteria, Flavobacterium* (Phosphorous Solublizers) *Vesicular arbuscular mycorhizae* (Phosphorous mobalizers) etc. Biofertilizers are cost effective, eco-friendly and renewable source of plant nutrient to supplements fertilizers for sustainable vegetable production. Hence becomes an integral part of INM. These biofertilizers are used as seed, seedling and soil inoculant. Biofertilizer application in vegetable production has attained significant importance, as they were found to improve soil fertility, sustain yield and quality of vegetables and reduce pollution (Chattoo *et al.,* 2003; Rather *et al*., 2003). Biofertilizer such *Azotobactor, Azospirrilium.* Phosphobacteria and VAM have been found to economize the N and P fertilizer up to the tone of 25-50% and increase yield by 1-25% (Table-4& 5). Biofertilizer application has brought social, economic and environmental benefits. Application of half RFD + biofertilizers could produce more or less the same economic yields but helps in saving of 25-50% dose of applied N and P.

Green manuring : The practice of ploughing or turning into the soil undecomposed green plant tissue for the purpose of improving physical condition as well as

Table-6 : Estimates of the available and realizable plant potential from the residues of principal crops in India.

Crop	Residue yield (000' tones)	Nutrient content (%)			Nutrient potential (000' tones)
		N	P	K	
Rice	80744	0.61	0.09	1.15	1493.8
Wheat	44987	0.48	0.07	0.98	688.3
Sorghum	11563	0.52	0.10	0.21	216.2
Maize	6219	0.58	0.09	1.25	119.4
Pearl millet	8283	0.45	0.07	0.95	121.6
Barley	3180	0.52	0.08	1.25	88.8
Sugarcane	15645	0.45	0.06	1.20	270.7
Potato	5062	0.52	0.09	0.85	73.9
Groundnut	9580	1.65	0.012	1.23	277.3
Total	185263				3320.0

Source : Bharadwaj and Guar (1985).

Table-7 : Effect of sewage on the yield of vegetable crops.

Crops	Yields (t/ha)			
	Well water	Untreated sewage	Primary treated sewage	Diluted (1:1) sewage
Cabbage	13.3	14.8	16.4	15.7
Cauliflower	16.4	18.2	19.7	16.9
Okra	3.1	3.4	4.8	4.0
Tomato	13.7	15.5	16.4	16.1
Brinjal	9.1	12.1	12.7	10.1
Potato	6.4	7.1	8.1	7.1

Source : Juwarkar (1994)

fertility of soil is referred to as green manuring and the manures obtained by this method is known as green manures. Crops here aregrown either insitu or brought from outside and upon decomposition, besides releasing nutrients, they add organic matter, produce enzymes, vitamins and antibiotics.It helps in improving physical and chemical properties of soil, absorb nutrients from the lower layer of soils and leave them in the soil surface layer when ploughed in for use by the succeeding crops.Green manuring helps to maintain organic matter status of soil, acts as source of food and energy to soil microbes and increases their population. Prevents leaching of nutrients to lower layers, increases aeration of rice soils by stimulating the activities of surface films of algae and bacteria, reduces soil temperature and protects the soil from the erosion action of water as it forms canopy cover on the soil.Green manuring is known to increase the crop yield by 15- 20% besides improving the quality. Sharma and Sharma (1998) reported 4.5 and 4.7 t/ha increases in tuber yield due to green manuring by dhaincha and sunhemp respectively. While in presence of fertilizer, these two green manure crops resulted in a nitrogen economy of 48 and 44 kg ha^{-1} respectively. Beneficial effect of green manuring in vegetable crops has also been reported by Upadhayay and Sharma, 2000.

Crop Rotation : Crop rotation is beneficial in sustaining both yield and quality of vegetables, as it has a potential to overcome all those factors which are responsible for decline in yield like loss of soil fertility, unbalanced nutrient uptake and presence of pest and weeds, legumes in rotation have been found to increase the yield by 25-30%, besides fixing atmospheric nitrogen to the extent of 30-40 kg ha^{-1} in tropical and sub-tropical regions. Singh *et al.,* (1991) reported that legumes in rotation can fix nitrogen from 100-200 kg/ha within 55 days. Rhizobial inoculation can improve the potential of legumes. Thus crop rotation can be an effective tool in integrated nutrient management for realizing sustainableyields.

Crop Residues : Crop residues are non-economical plant parts that are usually left in the field after harvest, left in packing sheds or processing units and serve as a potential source of nutrients, besides promoting and improving soil and water conservation, soil fertility and crop productivity. The potential of crop residues available for recycling in the country has been

Table-8 : Effect of sewage on the yield of vegetable crops.

Crops	Yields (t/ha) undiluted sewage	Diluted (1:1) sewage	Canal water
Beet root	16.27	15.60	8.75
Carrot	11.75	8.72	9.71
Radish	8.33	6.14	7.26
Potato	9.33	7.00	6.12
KnolKhol	16.57	11.76	9.70
Cabbage	12.13	11.32	9.27
Cauliflower	9.09	7.08	9.96
French beans x	8.06	8.20	6.63
Tomato	13.38		10.01

Source : Mahida (1981)

estimated to be 185263 thousand tones with a nutrition potential of 3320 thousands tones. Combined application of crop residues and chemical fertilizers is a better option for obtaining sustainable vegetable yields, besides improving the soil health. Upadhayay and Sharma (2000) advocated the application of crop residues at the rate of 15 t/ha for harvesting sustainable yields in cowpea and potato.

Sewage and Sludge : Sewage has been used in agriculture from start of human civilization. Application of sewage in agriculture offers a promising alternative, as sewage is rich in organic matter and nutrients and can be a substitute for irrigation water. The potential benefits of this practice include reduced cost of treatment and energy inputs, reduction/elimination of problems related to sludge handling storage and disposal as well as an increase in the amount of organic matter in the soil. Nutrient supplying potential of sewage is directly related to its composition. In general the sewage contain more than 90% water. The solid portion contains 40-50% organics, 30-40% inert material, 10-15% bio-resistant organics and 5-8% miscellaneous substance on oven dry basis. It contains good amount of NPK and micronutrients like Fe, Zu, Cu, and Mn. However, sewage also contains heavy metals like Pb, Cd, Cr, Co and Ni. These heavy metals pose serious problems regarding metal pollution, eutrophication and ground water contamination by nitrate and health risks from pathogens, are of great concern. Sewage has a positive effect on vegetable production and it not only increases the yield but has also resulted in the improvement of soil physical properties and level of macro and micronutrients (Mahida, 1981, Juwakar *et al.,* 1994).

Advantages of INM

Supply macro, secondary andmicronutrient and improve soil physicalproperties.

When applied with mineral fertilizers, it improves the efficiency of latter due to their favorable effects on soil properties increase nutrientavailability.

Add nutrients to the soil and reduce dependence on fertilizer.

Organic manures increase P availability as they have very high cation exchange capacity (Gaur, 1990).

Organic manures exhibits residual effect, as they are not fully utilized by the crop in the 1st year of application. Nitrogen released by them is very slow (less than 30%) and the balance becomes available for the subsequent crop.

Improves soil tilth and water holdingcapacity.

Constraints in Adoption of INM : The technology developed for implementing INM does not find popular acceptance among the farmers up to the expected level owing to some constraints.

Chemical fertilizers are still seen as a progressive approach by vegetablegrowers.

Lack of awareness among the farmers regarding its utility and importance.

INM is skill oriented and knowledge intensive technology needs much understanding oforganics.

Farming community does not find this approach acceptable, as it will take much time to change their attitude from the chemical fertilizers for ideological reason; the benefits have to be immediate forthem.

Lack of manpower, as INM is a knowledge intensive technology.

Information on the use of organics and chemical fertilizers islacking.

Lack of proper coordination among teachers, Extension workers andfarmers.

Slow action of organic sources of plantnutrients.

Inadequate supply of biofertilizers, vermicompost and other sources of plant nutrients coupled with their quality production.

Lack of adequate literature and good extension activities faced by the farmer in the adoption ofINM.

Future Strategies : In order to provide a sound and logical support for successful implementation of INM in near future following steps need to be taken :

Greater awareness needs to be created among the farmers on farm resource generations and its proper recycling to serve ruralneeds.

Soil test laboratories should be strengthened and up graded for soil/plant analysis (Macro/ micronutrients).

Generation of block/District wise data base on nutrient resources.

Greater awareness needs to be created among the farmers about the soil health, for monitoring soil nutrient status on regular basis through soil and plantanalysis.

Advantages of introduction of green legumes in the cropping systems should bepromoted.

Nutrient drain through crop, leaching, gaseous/ volatilization, erosion etc, need to beevaluated.

Enhancement of shelf life of biofertilizers, development of new strains through genetic engineering, development of techniques for assessing viability of bio-fertilizers. Popularization of biofertilizers are of paramount importance.

Promotion/popularization of compost production.

INM practice is for the farmers, by the farmers and of the farmers. Therefore it should be implemented in farmer's participatory mode right from the planning, implementation and monitoring.

Environmental concerns should be given sufficient prominence while developing INM technologies.

CONCLUSIONS

In future we have to produce more solanaceous vegetables for increasing population under limited plant nutrient resources. Sustainability advocates an integrated use of various production resources in a manner to mention/enhance productivity on one hand and to safeguard soil health and quality on the other. The prolonged and over usage of inorganic fertilizers had adversely effected, human and soil health, besides creating serious concerns of environmental pollution. The farmers are also looking for low cost input alternatives mainly of N fertilizer, which constitute a major component among the chemical fertilizers used in solanaceous vegetable production. Hence the use of integrated nutrient management becomes indispensable for maximizing solanaceous vegetable production, productivity, sustaining soil health and quality. The crop produce/products received through INM will not only be higher in bulk but also high in quality in terms ofnutrition.

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