ABSTRACT
Indian agriculture has been successful in increasing crop yield production in the past. For increasing the yield, accompanied by the series of problems related to the natural resources. Application of chemical fertilizer with organic manure that can improve soil fertility, soil properties as well as productivity in a sustainable manner. Integrated nutrient management is practiced by applying the organic manures and fertilizers in combination after assessing what the soil can provide through soil testing, and the crop nutrient requirements to give certain amount of yield.


Integrated nutrient management (INM) is the maintenance of soil fertility and plant nutrient supply at an optimum level to sustain the desired crop productivity. INM has been considered a broad based remedy against soil fertility decline, the management practices advocated by scientists viz., FYM or bio compost, green manures like sun hemp or dhaincha as in situ application, bio-fertilizers, crop residue mulching, etc. Sufficient and balanced application of organic manures and fertilizers are the focus in INM. Improved methods of application along with proper timing of application are also considered to achieve the best efficiency of used organic manures and fertilizers.

MATERIALS AND METHODS
In August 2017, literature reviews were collected different aspects about effect integrated nutrient management on soil health (effect on physical properties, effect on chemical properties, effect on biological properties and effect on crop yield) were confined to internet searches using search engines provided by Google throughout the world. The literature review found some published like reports of about integrated nutrient management, research papers and thesis within the past years.

RESULT AND DISCUSSION
INM (100% RDF (40:20:00 NPK kg ha⁻¹) + FYM @ 10 t ha⁻¹) recorded significantly higher seed yield of Niger and organic carbon (OC) content in soil after harvest of Niger than fertilizer alone treatment (Anon. , 2007).

Khanpara et al. (2008) found significantly higher available N and K in soil after groundnut and K in soil after wheat with 100% N through FYM. Pod yield of groundnut was recorded with 100% N through FYM but higher wheat grain and economic return was recorded with inorganic fertilizer (100% RDF as per soil test).

Kumar et al. (2012) observed that 100% RDF + FYM @ 5 t ha⁻¹ + GM (Sesbania in situ) + S @ 40 kg ha⁻¹+ Zn @ 15 kg ha⁻¹ + Mn @ 10 kg ha⁻¹ + Fe @ 10 kg ha⁻¹ resulted into significantly higher water holding capacity (WHC), OC, available P, S, Zn, bacteria, fungi and Actinomycetes in soil, significantly lower soil BD and higher rice equivalent yield, whereas significantly higher available N and K with 100% RDF + FYM @ 5 t ha⁻¹ + GM in rice – mustard cropping sequence.

All the INM treatments applied to garlic crop at Junagadh recorded significantly higher values of OC, available K, S and Fe contents in soil than control and RDF alone (Anon. 2012).

Chesti et al. (2013) found highest built-up of OC in soil after three year of continuous application of 100% NPK (100:60:30 NPK kg ha⁻¹) + FYM @ 10 t ha⁻¹ which was statistically at par with 50% NPK + FYM @ 10 t ha⁻¹ and 50% NPK + 10 kg Zn ha⁻¹ + 10 t FYM ha⁻¹ in soil. Similarly significantly higher available N, P, K in soil and wheat grain yield was recorded in 100% NPK (100:60:30 NPK kg ha⁻¹) + FYM @ 10 t ha⁻¹.

Pawar et al. (2013) application of 50% RDF + 50% N through FYM significantly increased hydraulic conductivity (HC), mean weight diameter (MWD), OC, available N, P, K, soil microbial biomass carbon (SMBC), soil microbial biomass nitrogen (SMBN), dehydrogenase activity (DHA). Whereas 100% RDF (80:40:40 NPK kg ha⁻¹) recorded significantly higher seed cotton yield. Significantly higher SMBC, SMBN, DHA were recorded with conservation tillage than conventional tillage.

Significantly lower pH and EC of soil and higher grain yield of sorghum was recorded in raised bed land configuration than flat bed. OC and ESP were not influenced significantly due to land configuration. The significantly lower EC, pH and higher OC after harvest of sorghum was recorded with INM treatment consisting of 75% RDF + FYM @ 10 t ha⁻¹ (Anon., 2014).

Gharpinde et al. (2014) revealed that 100% RDF (30:75:00 NPK kg ha⁻¹) + 25 kg K₂O kg ha⁻¹ + Biofertilizer (Rhizobium + PSB) recorded significantly higher OC, available N, P, K in soil after harvest of soybean and grain yield while it was statistically at par with 100% RDF + 25 kg K₂O ha⁻¹ and 100% RDF + Biofertilizer.

Dutta and Sangtam (2014) found that significantly lower bulk density (BD) and higher WIC, OC, available K with application of 1/2 N + P + 1/2 N forest litter than control and other INM treatments. Application of NPK + Poultry litter increased % aggregate (>0.25mm), MWD and available N. While NPK + FYM + Zn @ 10 kg ha⁻¹ resulted into significantly increased CEC. Increased in soil pH with Forest litter burned + 1/2 FYM and available P with NPK +
FYM was recorded after harvest of upland rice under acid soils of Nagaland.

Application of organics (FYM @ 10 t ha\(^{-1}\) + N fixer-A, PSB and chopped crop residues of same plot) significantly increased WHC, OC and BD than INM treatments but remained statistically at par with organic (FYM @ 10 t ha\(^{-1}\) + N fixer-B, PSB and chopped crop residues of same plot) and integrated (FYM @ 5 t ha\(^{-1}\) + N fixer-B + \(1/2\) N + PSB + \(1/2\) \(P_2O_5\)) significantly increased available N, P, K, CEC in soil and green pod yield of French bean (Gaurav et al., 2014).

Dubey et al. (2014) studied that nutrient management with 100% organics and INM treatment increased fungi, bacteria, Azotobacter, PSB and Actinomycetes population in soil after completion of crop sequences. In case of cropping sequences, Green manure (sunhemp) – Rice (basmathi) - Durum Wheat recorded numerically higher Azotobacter, PSB, Actinomycetes counts in soil while higher fungi, bacteria count were recorded in Rice – Berseem (fodder and seed). The significantly higher rice equivalent yield was recorded with Rice – Potato – Okra cropping sequence.

Gudadhe et al. (2015) noted that application of FYM @ 10 t ha\(^{-1}\) + 100% RDF recorded significantly higher OC content, bacteria, fungi, Actinomycetes count and lower pH, EC values of soil. Higher available N, P, K in soil was recorded with application of 75% RDF + 25% RDN through vermicompost after harvest of cotton. Significantly higher values of available N, P, K, bacteria, fungi and lower pH, EC were recorded in no application of nutrient to chick pea crop treatment while higher OC, Actinomyces, cotton equivalent yields were recorded with 100% RDF to chick pea.

Salvi et al. (2015) concluded that application of 100% RDF (100:50:50 NPK kg ha\(^{-1}\) + ZnSO\(_4\) @ 25 kg ha\(^{-1}\) + borax @ 5 kg ha\(^{-1}\) + FYM @ 10 t ha\(^{-1}\) + Azospirillum @ 2 kg ha\(^{-1}\) to okra recorded significantly higher MWHC, OC, available N, P, K while OC and available P was statistically at par with RDF + ZnSO\(_4\) @ 25 kg ha\(^{-1}\) + borax @ 5 kg ha\(^{-1}\) + FYM @ 10 t ha\(^{-1}\).

Application of 50% RDF + MS (Maize stalk incorporation with cellulolytic culture) + BF (Azospirillum +PSB) + GM (sunhemp) recorded significantly higher HC, maximum water holding capacity (MWHC), percentage stable aggregate (PSA), MWD, OC and lower BD after six year experimentation with kharif maize. Whereas available N, P, K content in soil and grain yield of maize increased significantly with 100% RDF + BF (Azospirillum +PSB) + GM (sunhemp) (Gundur et al., 2015).

Significantly higher %WSA (0.5 to 1.0 mm and >1.0 mm), available N, \(P_2O_5\), \(K_2O\), S, in soil and cabbage head yield were recorded with 100% FYM, 100% Biocompost and 75% FYM + 25% Scutching waste which were applied FYM @ 10 t ha\(^{-1}\) carbon equivalent basis, common 100% RDF (100:50:50 kg NPK ha\(^{-1}\)) was also applied to all the treatments (Saini, 2016).

Application of 50% RDF + 50% N through FYM recorded significantly higher values of MWD, AWC, OC, available N, P, K and lower values of soil pH, EC than inorganic application. Similarly under conservation tillage recorded significantly higher values of MWD, AWC, OC, available N and P than conventional tillage (Wagh et al., 2016).

Indoria et al. (2016) recorded significantly higher values of MWD, HC, WUE, SOC, seed yield of soybean and lower BD with NPK + FYM @ 4 t ha\(^{-1}\) after harvest of soybean than control treatment.

At Waghai, application of vermicompost @ 2 t ha\(^{-1}\) + Biofertilizer @ 4 kg ha\(^{-1}\) (Azotobacter) recorded significantly higher soil OC which was statistically at par with 75% RDF + VC @ 1 t ha\(^{-1}\) + Biofertilizer @ 4 kg ha\(^{-1}\) (Azotobacter) and 75% RDF + VC @ 2 t ha\(^{-1}\) while significantly higher finger millet grain yield was recorded with 75% RDF + VC @ 21 t ha\(^{-1}\) (Anon. 2017).

Aapplication of FYM/Compost @ 20 t ha\(^{-1}\) + 100% RDF (inorganic source) in sugarcane plant crop recorded significantly higher soil OC while application FYM/Compost @ 20 tonnes ha\(^{-1}\) + 50% RDF (inorganic source) significantly higher available \(P_2O_5\), whereas application of FYM/ Compost @ 10 tonnes ha\(^{-1}\) + Biofertilizer (Azotobacter / Acetobacter +PSB) + soil test basis (NPK application) recorded significantly higher cane yield (Anon. 2017).

**CONCLUSION**

Integrated or combined application of organic (Farm Yard Manure, Biocompost, Vermicompost etc.), inorganic (fertilizers like Urea, DAP, SSP, MOP etc.) source of nutrients along with biofertilizer (Rhizobium, Azospirillum, Azotobacter etc.) not only increase the yield of crops but also improve the soil physical (BD, MWHC, MWD, WUE, hydraulic conductivity, WSA, etc.), chemical (pH, EC and available macro and micro nutrients) and biological (Bacteria, Fungus, Actinomycetes, Azotobacter, PSB etc.) properties in a sustainable manner.

**LITERATURE CITED**


Gaurav, K., Jadav, V. and Arslan, R. 2014. Research on the effect of organic, inorganic and included use of nutrients on symbiotic


Received on 30-11-2017 Accepted on 04-12-2017