Review on effect of integrated nutrient management on seed yield and quality of pulses

Abstract

Pulses are also called as food legumes, it's the earliest food crops cultivated by man and are sometimes called the poor man's meat as they are valuable sources of calories, proteins, vitamins and minerals. Seed is the most important input in agriculture. The production and productivity of quality seeds depends on various factors includes soil, nutrients, climate and performance of agricultural operations during the growth of the mother plant from sowing to harvest in pulses soybean, redgram, cowpea and moong etc. To maintain good soil health and protecting environment from fertilizer pollution, a balanced fertilization by integrated nutrient management approach is necessary that causes minimal damage to the ecosystem. Integrated Nutrient Management refers to the maintenance of soil fertility and of plant nutrient supply at an optimum level for sustaining the desired productivity through optimization of the benefits from all possible sources of organic, inorganic and biological components in an integrated manner. The inorganic fertilizers are fast acting. These nutrient sources dissolve quickly and are immediately available to the plants and provide essential nourishment in the form of nitrogen, phosphorus and potassium thus escapes deficiencies symptoms and further leads to better plant growth, seed yield and quality. The organic manures (FYM, vermicompost and poultry manure etc.) seems to act directly by increasing crop yields either by acceleration of respiratory process by cell permeability or by hormone growth action. It supplies nitrogen, phosphorus and sulphur in available form to plants through biological decomposition indirectly and increase Carbon: Nitrogen ratio further improves physical properties of soil such as aggregation, aeration, permeability, water holding capacity and other beneficial microbial population. Biofertilizers (i.e *Rhizobium and Trichoderma*) are living microorganisms when applied to seeds, plant surfaces or soil, colonize 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 add nutrients through the natural processes of nitrogen fixation bacteria having a great potential to fix atmospheric Nitrogen symbiotically in frenchbean, soybean, cowpea and chickpea etc. Hence the combined application of inorganic and organic manures along with bioinoculants significantly improves its vegetative and reproductive characteristics leading to higher seed yield and quality in pulse crops, maintaining soil health and protecting environment from pollution.

Key words: Organic, Inorganic, Biofertilizers, Seed Yield and Seed Quality.

Introduction

The challenge for agriculture over the coming decades will be to meet the world's increasing demand for food in a sustainable way. Pulses such as chickpea, green gram and red gram are a low fat source of protein with a high fibre content containing both soluble and insoluble fibres. Pulses also provide significant amount of vitamins and minerals like iron, potassium, magnesium & zinc and also abundant in B vitamins; including folate, thiamin and niacin and contain about twice the amount of protein found in whole grain cereals like wheat, oats, barley and rice.

Among countries of pulses production worldwide, India is the largest producer pulses. During Jan-Dec 2017, India's imports of pulses valued at USD 2696 million, which shared 22.8% among world's top importers, in spite of continued progress in agriculture, food and nutritional security is still a challenge in India due to: high population increase rate, uneven growth in agriculture biased towards wheat and rice. The challenge has further been aggravated by global climate change, poor soil health, declining soil fertility and mismanagement of fertilizers have made this task more difficult. The excess usage of synthetic fertilizers with minimum application of organic inputs results into nutrient deficiencies, deterioration of soil and also causes environment pollution.

The present cost of chemical fertilizers are higher and imbalanced nutrition leads to deterioration of soil fertility and reduction in seed yield and seed quality hence, there is an urgent need to optimize nutrient requirement of crops through integrated nutrient management approach using both organic and inorganic with on farm recycling for sustainable crop production. This will certainly help in enhancing the productivity, maintaining soil health and protecting environment from pollution.

In 2020 Integrated Nutrient Management, soil fertility and sustainable agriculture: Current Issues and Future Challenges, Integrated plant nutrient management (INM) is the combined use of mineral fertilizers with organic resources such as cattle manures, crop residues, urban/rural wastes, composts, green manures and bio-fertilizers useful for longer run. They call for an Integrated Nutrient Management approach to the management of plant nutrients for maintaning and enhancing soil health, where both natural and manmade sources of plant nutrients are used for improving the management of plant nutrients and soil fertility are presented.

Application of farm yard manure or vermicompost or poultry manure to the crops is an old practice, well decomposed FYM in addition to supply of plant nutrients, it acts as binding material and improves the soil physical and chemical properties. Potential of vermicompost to supply nutrients and to support beneficial microbes is being recognized recently, vermicompost is a rich source of nutrients, apart from containing the nitrogen fixers and other beneficial microbial population. Hence, these characters recognized the vermicompost as a biofertilizer ultimately increases yield in oat (Kale *et al.* 1992). Nitrogen is a component of protein, nucleic acids and other compounds essential for plant growth process. It is a major plant growth and yield determining nutrient required for crop as well as seed production. Bio fertilizer or microbial inoculants are eco friendly, non-bulky, cheap and renewable sources of nutrients for plant. These inoculants render nutrients in available from and in adequate amounts which are otherwise inaccessible to the plants. The application of bio fertilizers also helps in improving biological activities of soil.

Balanced fertilization should also include secondary nutrients and micronutrients, both of which are often most readily available from organic fertilizers such as animal and green manures. The major micronutrients that influence the crop growth are Copper (Cu), Zinc (Zn), Iron (Fe) and Magnesium (Mg). Besides these, micronutrients play an active role in increasing the yield and quality in seed due to activation of enzymes (Ashok *et al.*, 2008), Zinc is an essential component of various enzyme systems for energy production, protein synthesis and growth regulation. Its deficiency symptoms occur mainly in new growth. The most visible Zinc-deficiency symptoms are short internodes (rosetting) and reduction in leaf size. Zinc uptake by plants decreases with increased soil pH. High levels of available Phosphorus and Iron in soils also adversely affect uptake of Zinc. (Joshi *et al.*, 2007) so the application of micronutrients are beneficial for the crop growth and development.

Pulses for soil fertility and sustainability of cropping systems

Pulse crops chickpea, soybean, green gram and black gram etc. boost soil fertility and reduce the need for inorganic nitrogen fertilizers because they can fix nitrogen (N) from the atmosphere and provide organic matter to soils. Cereals followed by Pulse rotation helps to control weeds and reduce disease and pest infections. Pulses extract water and nutrients from deep soil through their deep (tap) roots that minimise the impact of water stress. The bacteria (rhizobia) in these nodules convert atmospheric nitrogen into ammonia, which is then absorbed by the plant. The annual global input of atmospheric nitrogen fixed biologically amounts to 195 megatonnes of nitrogen per year.

Components of integrated nutrient management (INM)

Integrated nutrient supply not only improves the physical, chemical and biological health of soil and increases the availability of both applied and native soil nutrients but also helps in retarding degradation of soil, deterioration of water and environmental quality by enhancing carbon sequestration and checking the losses of nutrient to water bodies and atmosphere. Techniques to conserve and add nutrients to the soil through the application of organic or in organic fertilizers can help to maintain and increase the nutrient reserves of the soil. But over supply of nutrients can also be a problem, causing economic inefficiency, damage to the environment and incertain situations, harm to the plants themselves and to the animals and humans that consume them or products made from them. Hence soil fertility maintenance requires a balanced application of inorganic and organic nutrient sources, one of the advantages of using organic sources is that it acts as slow release fertilizer and synchronizes the demand of nutrient by the plants, both in time and space, with supply of the nutrients from the labile soil and applied nutrient pools.

The various components of integrated nutrient management are: a) integration of soil fertility b) crop residues management c) use of organic manures like FYM and vermicompost d) biological agents e) genotypes f) balanced fertilizer nutrients g) Animal components includes diary, poultary and fisheries

The method of application of fertilizer, its nature and time of application influences the recovery of added nutrients. For example, ammonium nitrate is the best source of nitrogen among nitrogenous fertilizer for upland crops whereas ammonical and amide form of nitrogen are considered best among nitrogenous fertilizers for rice crop. For application of N, split application is superior to basal application. Use of nodule producing pulse crop are grown to fix atmospheric nitrogen. For Phosphorus, basal application is applied, split application of K is preferred. Good management practices of P-based fertilizer/manure, most cereal growing areas will overcome problem of low P availability (Ortiz- Monasterio et al., 2002). The availability of Phosphorus is affected by soil pH and is maximum when pH of soil is in between 5.5 and 7.5. In soils with pH < 5.5, acid soil conditions cause dissolution of aluminum and iron minerals which precipitates with solution P whereas in soils with pH > 7.5, basic soil conditions cause excessive calcium present in soil solution which precipitates with Phosphorus ultimately decrease the availability of Phosphorus.

Sheep and goat manure

The droppings of goats and sheep contain higher nutrients than FYM and compost. On an average, the manure contains 3 per cent N, 1 per cent P_2O_5 and 2 per cent K2O.It is applied to the field in two ways. The sweeping of sheep or goat sheds are placed in pits for decomposition and it is applied later to the field. The nutrients present in the urine are *wasted* in this method. The second method is sheep penning, wherein sheep and goats are kept overnight in the field and urine and fecal matter added to the soil is incorporated to a shallow depth by working blade harrow or cultivator.

Poultry manure

The excreta of birds ferment very quickly. If left exposed, 50 percent of its nitrogen is lost within 30 days. Poultry manure contains higher nitrogen and phosphorus compared to other bulky organic manures. The average nutrient content in this manure is 3.03 per cent N; 2.63 per cent P2O5 and 1.4 per cent K2O.

Concentrated organic manures

Concentrated organic manures have higher nutrient content than bulky organic manure. Some of the concentrated organic manures are oilcakes, blood meal and fish manure etc. These are also known as organic nitrogen fertilizer. Before their organic nitrogen is used by the crops, it is converted through bacterial action into readily usable ammoniacal nitrogen and nitrate nitrogen. These organic fertilizers are therefore, relatively slow acting, but they supply available nitrogen for a longer period.

Oil cakes

Oil is extracted from oilseeds, left over solid portion is dried as cake which can, be used as manure. The oil cakes are of two types:

- Edible oil cakes which can be safely fed to livestock; e.g.: Groundnut cake, Coconut cake etc., and

- Non edible oil cakes which are not fit for feeding livestock; e.g.: Castor cake, Neem cake, Mahua cake etc.

The main principles of integrated nutrient management (INM):

The main principles of INM includes: a) all sources of nutrients to optimize their input b) matching soil nutrient supply with crop demand c) reducing nitrogen losses. d) Build-up of abiotic stress should be minimal, e) degradation of land occurring due to soil erosion must be controlled, e) soil quality with respect to soil acidity, salinity and sodicity or toxic elements build-up must be minimized. The timing and amount of nutrient application in accordance with the crop nutrient requirements, is necessary to achieve maximum yields and improve nutrient-use in Integrated nutrient Management (Cassman et al., 2002).

It was also studied by Witt and Dobermann (2004) that nitrogen fertilizers with frequent application can potentially reduce nitrogen losses and increasing yield and quality of crop. It was also reported by Li et al., (2015) that fate of Nitrogen is an integrated consequence of Nitrogen uptake, immobilization, Nitrogen losses like volatilization, denitrification, leaching and runoff.

Integrated nutrient management on soil fertility:

Declining soil fertility and mismanagement of plant nutrients have made the task to provide food for the world's population in 2020 and beyond becomes more difficult. The negative consequences of environmental damage, land constraints, population explosion pressure and institutional deficiencies have been reinforced by a limited understanding of the biological processes necessary to optimize nutrient cycling, minimize use of external inputs and maximize input use efficiency, particularly in tropical agriculture (Kumwenda et al., 1996). But some responses can overcome these difficulties. The responses highlighted here comprise the approach commonly known as integrated nutrient management (INM). Institutional needs are discussed in the next chapter. The implementation of INM responses will require a concerted and committed effort by actors from a variety of sectors, including the private and public sectors, scientific and policy organizations and industrialized and developing countries

Gupta et al., (2006) also indicated that imbalanced use of fertilizers is an important issue in an Indian agriculture so now alternate option is combined use of organic and inorganic sources of essential nutrients increases the production and profitability of field crops and helps in plant growth. It was also observed by Kumar et al., (2009) and Ahlawat *et al.* (2023) that organic manures in combination with fertilizers will surely enhance crop growth.

Organic manure and bio-fertilizers are needed along with chemical fertilizers for better yield and better soil health. Research indicates that bio-fertilizers like Azotobacter and Azospirillum alone or in combination have great prospect for increasing productivity of wheat (Kumar and Ahlawat, 2004). Therefore, the objectives of this study were to recognize the yield and nutrient use efficiency trends and to assess the N, P, K budget as influenced by application of NPK fertilizers in combination with or without organic manures over the years.

The increasing fertility of soil and crop productivity through use of chemical or synthetic fertilizers has often affected negatively on biogeochemical cycles was also reported by Roberts (2008). Fertilizer leaching and run-off of nutrients, especially nitrogen (N) and phosphorus (P) results in degradation of environment. The different sources of nutrients which enhance the productivity of crops are: manure, biofertilizers, soil, irrigation water, and atmosphere. Absorption of nutrients by crops from the soil exceeded their restoration through fertilizers; manures causing imbalanced nutrients in soil were also reported by Gangawar and Prasad (2005).

Benefits of Integrated Nutrient Management:

Sufficient well balanced usage of organic and inorganic fertilizers is a major component of INM. Classical field experiments at the Rothamsted Experimental Station in England have provided a wealth of INM related information on crops grown continuously and in rotation under a variety of soil fertility amendments. A number of lessons can be learned about appropriate and balanced fertilization from these experiments. Continuously cropped wheat, without the benefit of organic and inorganic fertilizers, typically has low yields, on the order of 1.2 tons per hectare. Short fallow rotations of approximately one to three years have little effect on yields. The application of organic and inorganic fertilizers can increase average wheat yields to 6-7 tons per hectare. Wheat yields are highest (9.4 tons per hectare) when farmyard manure is applied, wheat is grown in rotation and inorganic fertilizers are used to top-up nitrogen availability.

Discussion:

Rhizobium, PSB inoculation and 100% nitrogen performed better regarding days to 50% flowering, days to maturity, plant height(cm), number of branches/plant, number of pods/plant and seeds/pod. Combined inoculation of biofertilizers along with 100% nitrogen proved most effective for producing higher seed yield (29.94q/ha) as compared to control (23.93q/ha). The results clearly showed that conjunctive use of organic manure and inorganic fertilizers along with biofertilizers resulted in higher productivity of field pea. (Vineeta Pandey, 2007).

Organic and inorganic combination of nutrient supply may be synergistic as organic source improve soil physical and biological environment which in turn increase the availability of nutrients from inorganic source. Further microbial activity brings about the transformation of insoluble inorganic nutrients to available forms which are easily taken up by the plant ex: Potash mobilizing bio-fertilizers, phosphorous solubilizing bacteria. The increase in seed yield is due to the cumulative effect of increased growth and yield attributes. This increase in grain yield might be due to the effect of biofertilizer inoculations. It is well known that PSB produce vitamin and IAA, GA like growth substances (Ponmurugan, 2016). These growth factors in combination with better nutritional condition have played a significant role for increasing the seed yield of field pea.

(Patil, 2010) found that protein content, nitrogen, phosphorus and potassium content and uptake by blackgram were significantly increased under treatment 100% RDF+FYM 5 t/ha and biofertilizers inoculation with and without inoculation with Rhizobium sp. + Pseuodomonas striata as compared to rest of treatments. Related findings were obtained by (Mukherjee, 2016) who reported significant increase in plant height and number of branches of field pea with full dose of RDF along with rhizobium and PSB. Likewise, P-solubilizing bacteria are able to solubilize unavailable soil phosphorus and increase the yield of crops (Adesemoye, 2009).

An application of 50 to 75% of the recommended dose of inorganic fertilisers and the remaining 25 to 50% through organics would give higher yield and good quality seed spice crops when compared with the application of 100% recommended dose of inorganic fertilisers. Micronutrients play a significant role towards improving growth, yield and quality of seed in pulse crops green gram, pea and soybean.

Conclusion: There will have to be a very substantial increase in the use of mineral fertilizers to meet the food needs of human populations by the year 2025 and further, especially in the developing countries, even though organic sources can make a larger contribution to supply plant nutrients. 2. There is a lack of prioritized and strategic problem-solving agricultural research that is related to plant nutrition management and the incorporation of mineral and organic sources of plant nutrients into the soil. 3. There is a need for participatory and farmer adapted approaches to technology development. 4. There is a need to emphasize to donors and national governments that in most developing country situations, attention to the future of their agricultural sectors is of paramount importance, including macroeconomic considerations and other related sectoral policies affecting transport and energy. Encouragement should be provided to FAO to develop further, to cooperate with all relevant organizations, a Code-of-Conduct on the effective and environmentally sound management system of plant nutrients, for dissemination at both national and international levels.

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