Effects of integrated nutrient management on plant growth, yield attributing characters and economics

Rajesh Kumar Pal, Ajay Singh, Anil and Aneeta Yadav
Faculty of Agriculture and Allied Industries, Rama University, Kanpur, Uttar Pradesh, India

Abstract

In India during the past three decades, intensive agriculture involving exhaustive high yielding varieties of pulses have lead to heavy withdrawal nutrients from the soil. The concept of integrated nutrient management has been found to be such promising not only in maintaining higher productivity but also in providing greater stability in crop production. Therefore site-specific nutrient management through soil-test recommendation based should be adopted to improve upon the existing yield levels obtained at farmers field. Effective management of natural resources, integrated approach to plant-water, nutrient and pest management and extension of rapeseed-mustard cultivation to newer areas under different cropping systems will play a key role in further increasing and stabilizing the productivity and production of rapeseed-mustard. The paper reviews the advances in proper land and seedbed preparation, optimum seedand sowing, planting technique, crop geometry, plant canopy, appropriate cropping system, integrated nutrient management and so forth to meet the ever growing demand of gram in the country and to realize the goal of more production of gram through these advanced managementtechniques...

Introduction

In India during the past three decades, intensive agriculture involving exhaustive high yielding varieties of pulses have lead to heavy withdrawal nutrients from the soil. The concept of integrated nutrient management has been found to be such promising not only in maintaining higher productivity but also in providing greater stability in crop production.

Chickpea (Cicer arietinum L.) generally known as “Chana” “Gram” or “Bengal Gram” in India. It is an important leguminous food grain. Chickpea is an herbaceous annual plant which branches from the base. It is almost a small bush with diffuse, spreading branches. The plant is mostly covered with glandular or non glandularhairs but some genotypes do not posses hair. It is a self-pollinating plant with chromosome number 2n=16. Chickpea is mainly employed for human consumption and also a small proportion forms the part of animal and poultry feed. Chickpea has one of the highest nutritional compositions of any dry edible legume and is not reported to contain any specific major anti-nutritional factors (Williams & Singh, 1987). A 100g of cooked chickpea contains 9% protein (8.86g), 60% water, 27% total carbohydrates (27.42g), 3% fat (2.59g). The mineral component is high in phosphorus (168mg/100g), calcium (49mg/100g), magnesium (48mg/100g), iron (2.89mg/100g) and zinc (1.53mg/100g) (source; wikipedia). Chickpea protein has the highest digestibility when compared to other dry edible legumes. Its deep roots also open the soil, which ensure better aeration and heavy leaf drop increases the organic matter in the soil. It can fix about 25-30 kg N ha-1 through symbiosis (Reddy and Reddy, 2005) and these minimize dependency on chemical fertilizers. The lipid fraction is high in unsaturated fatty acids, primarily linoleic and oleic acids. They are also a good source of calcium, magnesium, potassium, phosphorus, iron, zinc and manganese (Ibrikci et al., 2003). Chickpeas do not contain as high amounts of isoflavones as soybeans do (source; USDA-ARS, 2004), but provide more beneficial carotenoids such as β-carotene than genetically engineered “Golden Rice”. Thus, chickpea is considered a functional food or nutraceutical (Agharkar, 1991, Charles et al., 2002). While it is acheap source of protein and energy in the developing world, it is also an important food to the affluent populations to alleviate major food- related health problems. However, more research is necessary to elucidate and extend the food and nutritional benefit of this important food legume through breeding.

Having a capacity to stand in drought conditions, this crop doesn’t have the requirement of being fed with nitrogen fertilizers. Chickpea through its BNF (Biological Nitrogen Fixing) capability meets 80% of its nitrogen requirement and can fix up to 140 kg N/ha from air. It leaves substantial amount of residual nitrogen behind for subsequent crops and adds much needed organic matter to maintain and improve soil health, long-term fertility and sustainability of the agro-ecosystem

India is the largest producer of chickpea with about 63% of the total area under chickpea production lying in India. Despite being the largest producer in the world, India still imports significant quantities from different countries as domestic consumption is high. In 2014-2015, the country imported around 418,870 tones (source; Commodity profile of pulses – July 2016 from department of Agriculture, Cooperation andFarmers Welfare) of chickpea, about 5 % of India total production, primarily the Desi variety from Australia, Russia, Tanzania and Myanmar. Despite the restriction of export of pulses (No 78, RE 2013/2009-2014 at dgft.gov.in), as they are part of essential commodities, Kabuli chickpea and restricted quantities of Desi chickpea can be exported and they contribute to the largest share of Indian export basket of pulses. India exported around 190,230 tonnes of chickpeas (about 2.3% of total production) in 2014-2015 to Algeria, Pakistan, Shri Lanka, Turkey and the United Arab Emirates. With the observed increase in the level consumption of pulses in the past decade, the nation's domestic production of chickpea is important in reducing India's dependence on imports.

In 2015 – 2017 the total area and production of gram was 89.28 lakh hectares and 83.65 lakh tonnes respectively. Highest production has been received from Madhya Pradesh by 39%, and followed by Maharashtra (14%), Rajasthan (14%), Andhra Pradesh (10%), Uttar Pradesh (7%), Karnataka (6%) and other remaining states & UTs of India (10%) (Source: Internet DES, MoA, GoL http://www.commoditiescontrol.com)

In Uttar Pradesh during the years of 2012-13 the total area was 2367 ha production was 2332 tonnes and yield was 985 kg/ha, then in 2013-2014 the total area was 2305 ha, production was 2197.2 tonnes and yield was 736kg/ha respectively, then in the year 2014-15 area of cultivation was 2522 ha, production was 2197.2 tones and yield was 871 kg/ha (source; ICAR-Indian Institute of Pulses Research). Area of production cannot be stretch beyond certain limits, only possibly is the maximization of production per unit area per time and maintenance of soil fertility. Incorporation of organic manures and bio-fertilizer in combination with inorganic fertilizers improves improve the productivity of chickpea, ameliorates and sustain soil health also economize fertilizers need.

Among the bio-fertilizers Rhizobium, as nitrogen fixer and PSB as phosphate solubizer have gain much importance, and there has been encouraging response to inoculation with Rhizobium and PSB... The single inoculation of Rhizobium increased the nodulation and nitrogen activity, the 'phosphate-solubilizers' increased the available phosphorus content of the soil. Combined inoculation of Rhizobium and P. striata or B. polymyxa increased the above parameters and also the dry matter content, the grain yield and nitrogenase and phosphorus uptake significantly over the uninoculated control. The inoculation effects were more pronounced in the presence of added fertilizers. The possibilities of saving half the dose of N and replacing super phosphate with rockphosphate and inoculation with 'phosphate-solubilizers'. Thus for sustainable farming, farmers should adopt INM under which several organic sources of plant nutrients are use to compliment the supplement mineral fertilizers. This will help in maintaining soil fertility and its physico-chemical properties, agricultural productivity and thus improve farmer's profitability.

Effects of integrated nutrient management on symbiotic traits of chickpea crop

Tiwari et al., (2000) reported that the beneficial effect on applied phosphatic fertilizers along with Rhizobium inoculation on effective nodule numbers and dry weight nodules. The number of nodules at 45 DAS increases from 10-18 nodules plant-1 with Rhizobium inoculation. Dry weight of nodules is increase significantly with phosphatic fertilizers and Rhizobium inoculation treatments. Akdag and Duzdemir (2001) found that the Rhizobium inoculation in chickpea seeds had a significant positive effect on total plant weight as well as number and weight of effective nodules at 40 and 62 DAS respectively. Yadav et al., (2002) reported that the number of nodule and dry weight of root and shoot increase significantly in most of the chickpea genotypes due to the inoculation with Rhizobium culture as compared to control. Among the varieties, the HC-3 showed the maximum response and recorded the highest nodule numbers and dry weight as well as roots and shoots dry weight respectively. Das et al., (2002) observed the significant effects of vermin-compost and chemical fertilizer application on the growth and yield of green gram. They noted the greater number of nodules plant-1 and fresh weight of nodules plant-1 when crop receive a dose of RDF along with vermin-compost @ 2 t ha-1 over control. Khoja et al. (2002) observed that seed inoculation with Rhizobium + PSB significantly increase the plant height, number of branches and dry matter accumulation plant-1 as well as pods plant-1, seeds pod-1 and test weight, over un-inoculated treatment. Abdin et al., (2003) reported that the useof sulphur is considered to increase the efficiency of native sulphur as well as applied phosphorus. Both S and P are known to interact with almost all essential macronutrients, secondary nutrients and micronutrients. Nilambari et al., (2003) reportedthat t has been well documented that organic matternot only releases the nutrients during itsdecomposition but also provide substrate for microbial growth. Hence, the effect of Phosphorus and sulphur was enhanced when applied in conjunction with FYM. Ali et al. (2004) reported that the purpose of growth analysis is the determination of the increase in dry matter referred to a suitable basis for photo-synthetically active tissue, leaf area and amount of leaf protein Gupta (2004) reported that the use of Rhizobium and phosphate solubilizing bacteria either as seed treatment or as soil application significantly increase the nodule numbers (3.2 to 4.2 times) as well as nodule dry weight plant-1 over the control. Jat and Ahalawat (2004) reported that t has been well documented that organic matter not only releases the nutrients during its decomposition but also provide substrate for microbial growth. Hence, the effect of Phosphorus and sulphur was enhanced when applied in conjunction with FYM. Kennedy et al., (2004) reported that Indian soils are lacking in effective and specific strains of Rhizobium which are responsible for symbiotic nitrogen fixation. Some important strains are mentioned as plant growth promoting rhizobacteria (PGPR) and that can be used as bio- fertilizers. Hall, (2004) reported the decrease in leaf area index may be attributed to reduced growth and expansion of leaves. Khan et al., (2005) reported that application of PSB facilitates the root development vis-à-vis nodule formation and proper development of nodules by increasing the availability of phosphorus through the mobilizing the unavailable phosphorus present in the soil with increased levels of sulphur. Pagter et al., (2005) reported that drought stress leads to lower production of leaves, higher leaf senescence, decreased leaf size which may be attributed to decrease in vegetative growth. Alam and Haider (2006) studied the effects of N fertilizer on growth attributes of barley and found that total dry matter (TDM), leaf area index (LAI), crop growth rate (CGR) and net assimilation rate (NAR) increased due to N fertilization. Amany (2007) reported that urea foliar application had a significant impact on plant height, number of branches, pods and seeds plant-1, 1000 seed weight, TDM, seed yield and harvest index in chickpea. Karwasra (2007) reported that application of PSB + Rhizobium increase the availability of nutrients like N and P and more availability of nutrients resulted an increase in physiological processes viz., cell elongation, cell division and formation of meristematic tissues which ultimately enhanced growth attributes and dry matter production. Caliskan et al., (2008) reported that the supply of N to the plant will influence the amount of protein, amino acids, protoplasm and chlorophyll formed. Consequently, it influences cell size, leaf area and photosynthetic activity. Ogutcu et al., (2008) reported that inoculation with Rhizobium significantly increases the plant height, first pod height, number of branches, pods and seeds per plant, grain and dry matter yield in chickpea. Togay et al., (2008) N requirement through symbiotic N2 fixation when grown in association with effective and compatible Rhizobium strains. Khamssi et al., (2010) observed that decreased LAI in response to increased water deficit was observed in chickpea. Yaqoob et al. (2012) reported that this investigation showed the negative effect of drought on growth traits of chickpea. Varshney et al. (2013) reported that it is a self-pollinated crop with a basic chromosome number eight and a 738 Mb genome size. Chaturvedi et al. (2016) reported that more than 190 chickpea varieties for important traits have been released in India

Effects of integrated nutrient management on yield and yielding attributing characters of chickpea crop

Kradavut and Ozdemir (2001) found that seed inoculation with Rhizobium culture result in 20% higher yield of chickpea as compared to the control. Meena et al. (2001) reported that the Rhizobium + PSB seed inoculation significantly increase the number of seeds pod-1 and pods plant-1 in chickpea as compared to control. Mut and Gulumser (2001) recorded the highest yield of chickpea cv. Damla-89 due to seed innoculation with Rhizobium culture as compared to the control. Kanwar and Paliyal (2002) reported the effects of P2O5 and organic manures on the yield of chickpea. The highest grain yield was obtain with
50 kg P2O5 ha-1 along with 2 t ha-1 vermi- compost over 75 kg P2O5 ha-1. Meena et al. (2002) found that the phosphobacterium seed innoculation increased straw and grain yields, net return and benefits; cost ratio than that of recorded under control. Asewar et al. (2003) studied the integrated use of vermi-compost and inorganic fertilizer in chickpea. Application of vermi- compost @ 2 t ha-1 along with inorganic fertilizers recorded higher growth characters, plant height, no of branches plant-1, and yield attributing characters, pods plant-1, grain and straw yield as compared to application of inorganic fertilizers alone. Jat and Ahlwat (2004) reported that Rhizobium and PSB innoculated seed markedly enhance more dry matter (19.94 g plant-1), leaf area index (1.62), pods plant-1 (28.69) and grain and straw yield of chickpea as compared to control (18.24g, 1.38 g and 24.95 g) respectively. Siag et al., (2004) observed that the use of 75% RDF with 2t vermi- compost ha-1 were found effective in increasing growth, yield attributing characters, grain and straw yields in chickpea over application of RDF alone. Abdul et al. (2005) reported that phosphorus fertilizer application up to 60 kg P20s/ha linearly increased the grain yield of chickpea. Chaudhary and Go swami, (2005) also reported that phosphorous application accelerated the production of photosynthates and their translocation from source to sink, which ultimately

gave the higher values of yield contributing characters with increasing levels of phosphorus and sulphur. Rudesh et al. (2005) reported that combined inoculation of Rhizobium, PSB and Trichoderma spp. Showed increased germination nutrient uptake, plant height, number of branches, yield and total biomass in chickpea over un-inoculated control. Meena et al. (2006) reportedthat phosphorous application accelerated the production of photosynthates and their translocation from source to sink, which ultimately gave the higher values of yield contributingcharacters. Kumar et al. (2007) also reported that phosphorous application accelerated the production of photosynthates and their translocation from source to sink, which ultimately gave the higher values of yield contributing characters. Mustafa et al. (2008) found that the 100°/o recommended dose of N and P +Rhizobium+ PSB has resulted in higher growth, yield attributes and yield of chickpea. Sarna et al., (2008) observe that the increase in yields with biofertilizers was mainly due to the increase in almost all growth and yield contributing characters, which ultimately resulted a significant increase in grain and straw yields. Singh and Prasad et al., (2008) observed that enhanced yield attributes under irrigation practices, which contributed favourable condition for plant growth by increasing the availability of nutrients to plant and enhancing the branching and leaf area for photosynthesis. Tolanur (2008) observed that the yield of chickpea and uptake of micronutrients (Zn, Cu, Fe and Mn) increased significantly with 50°/o N through green manure and 50 % N through inorganic fertilizer. Tolansur (2008) reported that the chickpea yield and uptake of micronutrient increased significantly with 50% nitrogen. Gan et.al., (2009) reported that Chickpea (Cicer arietinum L.) crop received N fertilizer at 0,28,64,84 and 110 kg N ha-1 and found that increasing N rates increased seed yield significantly. Panwar et. al., (2009) reported that chickpea crop in the four years (2007-08), the productivity of this crop was improved by 11.1, 1.1, 3.0, 4.2 and 11.2% than chemical fertilizer by which treatment. Salehpour et al., (2009) reported that reduced number of leaves and leaf area inresponse to water deficit was noticed in chickpea. Tolanur (2009), A field experiment was conducted to study the effect of different organic manures with different levels of inorganic fertilizer N 50% N and 100% N recommended dose of N (RDN) on grain yield and uptake of major nutrients (N, P, K) in Vertisol. The highest grain yield and uptake of NPK by chickpea were obtained when 50 percent N through subabul/sunhemp as green manure plus 50 percent recommended dose of fertilizer N-was applied. Kaya et al. (2010) carried out a study at Suleyman Demirel University research farms, Turkey. The aim of the study was to investigate the effect of sowing times and different seed treatments on 100 seed weight, harvest index, seed yield, and protein content in 3 chickpea cultivars (Gokce, Akcin 91, and Ispanyol). 100 seed weight, harvest index, seed yield, and protein content were recorded as 32.7-44.2 g, 38.7-54.1%, 63.1-180.3 kg/ha and 20.1-27.3%, respectively. 100 seed weight, harvest index and seed yield were significantly affected by sowing dates and seed treatments. On the other hand, protein content was highly affected from late sowing and gibberellic acid (GA3) treatments. It was concluded that early sowing along with 100 ppm GA3 and dH2O treatments could be practiced to obtain higher seed yield in chickpea Khamsi et al., (2010) reported that under high moisture stress, high correlation coefficient values were found between seed yield and related traits should be considered in improving yield stability of chickpea under moisture stress conditions. Yield was found positively correlated with plant height, number of branches, 100 seed weight, number of pods per plant and leaf area index. Maida (2010) reported that chickpea variety JG 130 was found higher yielder than JG 315, JG 16, JAKI 9218 and JG 11. Shamsi et al., (2010) reported that under high moisture stress, high correlation coefficient values were found between seed yield and related traits should be considered in improving yield stability ofchickpea under moisture stress conditions. Yield was found positively correlated with plant height, number of branches, 100 seed weight, and number of pods per plant.

Economics of chickpea

Patel et al. (2003) this study reveals that majority (91%) of chickpea growers (n=200) in Bhopal district, Madhya Pradesh, India, has completely adopted recommended field preparation practices, improved varieties, sowing time, seed rate, sowing methods and time of harvesting, whereas 53- 63.6% have partially adopted seed treatment, balanced dose of fertilizers, insect control and irrigation management. 85% of the respondents have not adopted soil testing and weedmanagement practices. Irrigation intensity, extension participation, socioeconomic status, information seeking behaviour and risk preference were found to be significantly related to adoption behaviour. Singh et al. (2005) studied the costs andreturns of pulses production in Hanumangarh district, Rajasthan. Results revealed that the highestexpenses incurred in the cultivation of pulse crops were on harvesting, threshing and seed. Among thepulse crops, moong and moth beans were found to give higher returns per hectare as compared to gram. This was because of higher prices for moongand moth beans. Though the average yield of gram was observed to be higher, the net returns per hectare of all pulse crops were low on small farms due to inefficient use of modern inputs and low yield. The pulses were not much profitable because of low productivity, absence of improved production technology, less use of modern inputs, lack of irrigation water and adverse climatic conditions. Patole et al. (2008) reported that the use of the most important inputs per hectare was lower in sampled farms than in demonstration plots. A benefit: cost ratio of 1.19 for chickpea indicated the profitability of its cultivation. Production function analysis indicated the intensive use of human labour, bullock labour, nitrogen and phosphorous, and reduction in the use of manures for chickpea cultivation. The decomposition analysis of yield gaps showed that 52.99% of the potential farm yield in chickpea was left untapped by the sampled farmers. Therefore, chickpea production may be increased by at least 53%. Mayda (2011) reported that the overall gross income of chickpea (main product + by product) per hectare of this crop was found to be Rs.22688.00 and it decreased with the increase of size of holding. The other measurement of farm profit like net income was found to be on an average Rs.5864.62 per hectare. The net income per hectare was found to be the highest with small farmers i.e. Rs.8582.26 and lowest with medium farmers i.e. Rs.4467.37 followed by large farmers i.e. Rs.4544.24 per hectare. Kangali (2012) reported that in the case of adopter farmers, majority of the respondent were in partial level of adoption followed by full and low category respectively regarding adoption of chickpea production technology/ practices. On the other hand, in case of non adopter farmers, majority of the respondent were in low level of adoption followed by partial and full category (equal) respectively regarding adoption of chickpea production technology/ practices.

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