ISSN (Online) 2456 -1304

International Journal of Science, Engineering and Management (IJSEM)
Vol 2, Issue 10, October 2017

Role of Integrated nutrient management to sustain productivity of intercropping system

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Abstract: **Textile industry is the backbone of industrial economy of India and cotton is the basic raw material of the industry. Cotton the king of fibres, is an industrial commodity of worldwide importance besides earning foreign exchange. India stands first among all the cotton growing countries of the world with an area of 11.70 m. ha, which accounts to one fourth of the world cotton area; and production of 29 m. bales of seed cotton. In India, the productivity of cotton is 532 kg ha-1 as compared to Australia, Turkey and Brazil with 2151, 1484 and 1465 kg ha-1, respectively. To meet the projected target of cotton production by 2025 A.D. many approaches were evaluated, among them intercropping, an agronomic approach was found to be better way. Intercropping helps in the total production with higher returns under dryland conditions, besides better utilization of natural and scarce resources per unit time. Suitable management practices like intercropping, judicious combination of organic and inorganic manures are considered ecologically viable, economically feasible and avoid environmental pollution which ensures sustainability in crop production. Combination of organic and inorganic manures works like slow release fertilizers for providing balanced nutrients to plants. Intercropping of cotton with short duration legume like soybean was found more remunerative than sole cotton.**

***Index Terms*— Cotton, Soybean, Organic, Inorganic and Nutrients**

1. INTRODUCTION

Cotton plant being heavy feeder needs proper manuring and fertilization for its successful cultivation. To meet the projected target of cotton production by 2025 A.D. many approaches were evaluated, among them intercropping, an agronomic approach was found to be better way. Intercropping helps in the total production of different commodities with higher returns under dryland conditions, besides better utilization of natural and scarce resources per unit time [Sharma et al. 2000]. Companion crops under intercropping use growth resources differently when grown together and complement sometimes each other and make better overall use when compared to sole crops [Willey and Ruberts, 1979]. Intercropping of cotton with short duration legume like soybean was found more remunerative than sole cotton (Sarkar et al. 1995; Salwaru and Mohammed et al. 1995). Intercropping of cotton with soybean is more for production sustainability than yield advantage under rainfed condition. As per the package of practice of UAS, Dharwad, Cotton and Soybean intercropping (1:2 rows) is recommended with spacing of Cotton 120 cm x 60 cm in 40 cm rows [Anon., 2014].

Intercropping, the agricultural practice of cultivating two or more crops in the same space at the same time, is an old and commonly used cropping practice which aims to match efficiently crop demands to the available growth resources and labor. Enhancement of cotton yield is also possible by intercropping with a short duration legume due to their complementary effect of fixing atmospheric nitrogen. Intercropping in cotton may also have adverse effect on the other crop, but could be adequately compensated by the extra yield from intercrops. Application of organic manures along with inorganic fertilizers helps to rejuvenate the graded soils and ensures sustainability in crop production. Suitable management practices like intercropping and judicious combination of organic and inorganic manures are considered ecologically viable, economically feasible and avoid environmental pollution. In addition, combination of organic and inorganic manures works like slow release fertilizers for providing balanced nutrients to plants.

2. GROWTH, YIELD AND QUALITY

Self-sustaining, low-input, and energy-efficient agricultural systems in the context of sustainable agriculture have always been in the centre of attention of many farmers, researchers and policy makers worldwide. Two sets of field experiments were conducted during kharif and rabi seasons of 2002-03 and 2003-04 at New Delhi under irrigated conditions to formulate site-specific nutrient management strategies for cotton-sunflower cropping system. The kharif experiments on cotton consisted of eight treatments viz., 100% recommended dose of fertilizers (RDF; 60:30:30 N, P2O5 and K2O kg ha-1), 50% RDF, mungbean intercrop incorporation (MII), farm yard manure (FYM; 12 t ha-1), 50% RDF + MII, 50% RDF + FYM, 50% RDF + FYM + MII and control. Highest values for seed cotton yield and NPK uptake were observed for the combined application of all three nutrient sources. Nutrient management of cotton also exerted a marked effect on seed

ISSN (Online) 2456 -1304

International Journal of Science, Engineering and Management (IJSEM)
Vol 2, Issue 10, October 2017

yield and NPK uptake of the succeeding sunflower crop. However, direct application to sunflower had a more pronounced effect than the residual effects [8]. Field experiment at Coimbatore in cotton crop, results revealed that fifty per cent of (40 kg N ha-1) recommended dose of N was substituted with green manure (sunhemp) and the remaining 50 per cent with the organic sources viz., farm yard manure, vermicompost, poultry manure, goat manure, and pressmud for the organic manuring treatments. With respect to the uptake of nutrients (NPK), the recommended dose of NPK through inorganic source and 50 per cent of N through sunhemp + 50 per cent of N through vermicompost were found to be superior to other treatments. Whereas, the post harvest soil available N, P, K and soil organic carbon content were found to be higher in organic manures applied plots [Mohan and Chandaragiri, 2007].

A field experiment was carried out at Parbhani during kharif seasons of 2001 and 2002, to evaluate the effect of intercrops and fertilizer levels on yield and quality of different cotton genotypes under rainfed conditions. Increasing fertilizer level from 50% recommended fertilizer dose of both the crops (RFDB) to 100%. RFDB showed positive response in respect of seed cotton yield. Recommended dose of fertilizers of both the crops on area basis (RFDB) enhanced the ginning percentage and halo length significantly than 75% and 50% RFDB. Further, application of 75% RFDB also improved the ginning percentage and halo length than 50% RFDB [Kote et al. 2005]. Field experiments were conducted by [Jayakumar et al. 2008] at Tamil Nadu Agricultural University, Coimbatore, 75% inorganic N + 25% N through poultry manure recorded significantly higher plant height (132.7), dry matter production (453 kg ha-1), LAI (4.86), monopodial branches (1.93 plant-1), sympodial branches (26.35 plant-1), boll weight (3.79) and seed cotton yield (1965 kg ha-1) in cotton and greengram intercropping system.

The results after twenty years of experimentation at Akola, Maharashtra revealed that significantly highest yield of cotton and greengram with build up of soil fertility and maximum economic returns were obtained with the application of 25 kg N ha-1 and 25 kg P2O5 ha-1 through Urea and single super phosphate, respectively and 25 kg N/ha through FYM over the years in cotton and greengram intercropping system [Gabhane et al. 2013]. In one of the study conducted experiment at Madurai [Jayakumar et al. 2008]. The treatment consists of N1 - 100 % RDF (Recommended Dose of fertilizer – 80:40:40 kg NPK ha-1), N2 – 75 % RDF, N3 - 75 % RDF + biofertilizers, N4 -75 % RDF + 5 % Morinda leaf extract spray at 60 and 80 DAS, N5 - 75 % RDF + 5 % Vilvam leaf extract spray at 60 and 80 DAS, N6 - 75 % RDF + 5 % Annona leaf extract spray at 60 and 80 DAS. The biofertilizers include Azospirillum + Phosphobacteria + silicate solubilizing bacteria each at 2.6 kg/ha. Among the nutrient management treatments application of 75 % RDF + combined application of Azospirillum, phosphobacteria and silica solubilizing bacteria recorded higher microbial population and seed cotton yield. During both the years of study at Akola, Maharashtra, treatments of 125 % RDF and 100 % RDF being par recorded significantly higher seed cotton yield than 75 % RDF to base crop of cotton. In pooled analysis every additional dose of RDF to cotton was found significantly superior to its lower dose of RDF in recording higher seed cotton yield in 2007-08, 2008-09 and in pooled analysis [Saoji, 2015].

Field experiment at New Delhi by [Singh and Ahlawat, 2012], result of the study indicated that substitution of 25 % recommended dose of nitrogen (RDN) by FYM produced additional 180 kg lint ha-1 over no substitution, whereas substitution of 50 % RDN through FYM reduced lint yield by 150 kg ha-1over no substitution. Substitution of 25 % RDN through FYM and 100 % RDN (150 kg ha-1) through urea maintained similar uptake of macronutrients (N, P and K) in fibre, but 25 % RDN substitution through FYM recorded significantly higher uptake of micronutrients (Fe, Mn, Zn and Cu) over other treatments. For producing 100 kg lint of Bt cotton in fertilized treatments, it accumulated 590 g N, 400 g P, 380 g K, 55 g S, 21 g Fe, 4 g Mn, 2.5 g Zn and 2 g Cu in fibre. Substitution of 25 % RDN through FYM being on par with 100 % RDN recorded higher values of seed index, lint index and micronaire over other treatments. Fibre length and micronaire showed strong correlation with seed weight.

It was observed that incorporation of crop residue have beneficial effect on soil structure, porosity and water transmission were attributed to the protective effect against rain drop impact and of the pulverizing and mixing action of soil fauna than activity and linearly increase the infiltration rate [Lal et al. 1999]. In one of the study [Pawar, 2000] observed that in vertisol of Dharwad higher available N content of soil (261.96 kg ha-1) was recorded due to combined application of vermicompost @ 5 t ha-1 and 100% RDF. [Satyanarayana, 1997] recorded increase in available phosphorus content of soil at harvest due to incorporation of subabul, FYM and RDF when compared to control in black soil of Bijapur (Karnataka) One of the study [Baalaji, 2004] reported that higher level of potassium with either vermicompost alone or in combination with FYM or chemical fertilizer application in vertisol of Dharwad. It was noticed that significantly increased uptake of N, P and in soybean with application of RDF + FYM at 5 t ha-1 or RDF + vermicompost at 2.5 t ha-1 as compared to RDF alone. Nutrient uptake by soybean crop differed significantly higher crop residue, uptake of NPK was significantly higher in crop

ISSN (Online) 2456 -1304

International Journal of Science, Engineering and Management (IJSEM)
Vol 2, Issue 10, October 2017

residue incorporation (175.7, 10.0 and 127.8 kg ha-1) as compared to no residue incorporation (153.5, 9.0 and 108.8 kg ha-1, respectively) [Babalad. 1999].

The results of the two years' pooled data at Dharwad, Karnataka revealed that combined application of compost (50%) + vermicompost (50%) equivalent to RDF recorded significantly higher values of ginning per cent (34.26%), uniformity ratio (45.62%) and lower fibre fineness (3.71 g) over FYM @ 5 t ha-1 + RDF integrated application of compost (50%) + vermicompost (50%) equivalent to RDF + gliricidia GLM with surface application of jeevamrutha @ 500 l ha-1 recorded significantly more fibre length (35.62 mm), ginning per cent (34.60%) and lower fibre fineness (3.63 g) over RDF alone and FYM + RDF [Channagouda and Bablad, 2015]. The results of the study revealed that cotton + blackgram intercropping with application of 75 % RDF + combined application of azospirillum, phosphobacteria and silica solubilizing bacteria recorded higher soil available nitrogen and phosphorus content [Harisudan et al., 2010].

3. SYSTEM USE EFFICIENCY

Use of agrochemicals for fertilization and pest management led to a simplification of the components of agricultural systems and to a loss of biodiversity. Restoring on-farm biodiversity through diversified farming systems that mimic nature is considered to be a key strategy for sustainable agriculture. Higher CEY (cotton equivalent yield) was found when P applied through SSP than RP + PSB +AM. Application of 35 kg P/ha gave higher CEY over 17.5 kg P/ha. Further it was observed that cotton + peanut intercropping system maintained system productivity index (SPI) of near 4.0 and 25% substitution of RDN through FYM maintained the highest SPI over other fertility levels and it was 9.0% higher than the 100% RDN through urea. The results of actual yield loss (AYL) conformed that cotton was dominant species over peanut for all the treatments because of negative values for peanut in the system; however, the total AYL values were positive and greater than 0 in all the treatments. Among all the fertility levels, control maintained the highest positive values for total [Harisudan et al., 2010].

Among fertility levels, substitution of 25% RDN of cotton through FYM maintained higher apparent crop water productivity (17%), monetary advantage index (6%), system productivity index (9%) and nutrient use efficiencies (15-17%) over 100% RDN through urea only. This work provides basis for efficient resource use by peanut intercropping with cotton which simultaneously enhances domestic oilseed production and reduce import load of cooking oil without sacrificing the productivity of main crop of cotton in India and other cotton growing countries of the world [Singh et al., 2015].

4. ECONOMICS

The higher seed cotton equivalent yield (groundnut 0.3 t/ha and soybean 0.1 t/ha) coupled with corresponding stover yield with minimal increase in cost of cultivation has resulted in higher net returns and B:C ratio in intercropping system over sole cotton [Choulwar et al., 2015]. [Gabhane et al., 2013] revelaed that the highest B:C ratio of 1.72 was recorded in treatment of 100% RDF through inorganic fertilizers (T2) followed by 1.67 in the treatment receiving 25 kg N + 12.5 kg P2O5 ha-1 through fertilizers (T3). Hence, on the basis of long term experimentation, it is concluded that, Integrated Plant Nutrient Supply system through application of 25kg N + 25kg P2O5 ha-1 through Urea (55kg) and SSP (156 kg) and remaining 25kg N ha-1 through FYM (5000 kg) to cotton and greengram (1:1) intercropping system sustains fertility and productivity of soil in dryland agriculture.

5. CONCLUSION

Considering the multiple advantages that can occur from intercropping, particularly in the seek of sustainable agricultural systems, and the environmental problems with current farming systems, it seems reasonable to continue research on the possibilities of growing more than one crop in a field at the same time.

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