SOIL FERTILITY CHANGES AND CROP PRODUCTIVITY OF BANANA BY CONTINUOUS ADOPTION OF BANANA-COWPEA INTERCROPPING WITH NUTRIENT MANAGEMENT PRACTICES

Abstract

Banana is one the important fruit cum cash crop and which is cultivated to an extent of 2000 ha in Namakkal district, Tamil Nadu. Six blocks in the Namakkal district are the major belts cultivating banana crop. Single or mono cropping of banana is the normal practice adopted by farmers and meager population is cultivating pulses (green gram & black gram) and small onion as intercrop in banana for their family consumption. At the same time growing of weeds, water scarcity, shortage of agricultural labours during monsoon, deficiency in available nutrients (OC-62%, N -67%, Zn-98%, B-58%) addressed as common problem in all areas. In addition, continuous cropping without soil test based fertilizer recommendation leads to the widespread nutrient deficiency in the soil and reduction in yield of crops. Fruit cracking, pest & disease incidence and poor withstanding capacity of crops under drought condition might be associated with nutrient deficiency and thus leads to 18-25 % reduction in yield of crops. To overcome this, front line demonstration (demo) was conducted in farmer's field in an areas of 8 ha in DFI village of Krishi Vigyan Kendra. Growth and yield attributing characteristics was recorded higher in demo plot than farmers practice (check). Highest banana yield of 34.80 t ha^{-1} was recorded in the demo plot (KVK intervention from sowing to harvest) whereas farmers practice (check) recorded 30.24 t ha^{-1}. The demo yield proved its superiority by recording 15.08 % yield increase over check and having higher net return of Rs.1,89,543 with BC ratio 2.30 than check.

Key words: Banana - Cowpea intercropping - Nutrient management practice - Soil fertility changes - Yield

Introduction

Banana is one the important fruit crop and which is cultivated to an extent of 2000 ha in Namakkal district, Tamil Nadu. Mohanur, Paramathi, Namagiripettai, Kollihills, Sendamangalam, Thiruchengode blocks are the major belts cultivating banana crop. Single cropping of banana is

the normal practice adopted by farmers and meager population is cultivating pulses (green gram & black gram) and small onion as intercrop in banana for their family consumption. At the same time growing of weeds in between the space of main crops, water scarcity, shortage of agricultural labour's during monsoon, deficiency in available nutrients (OC-62%, N -67%, Zn-98%, B-58%) addressed as common problem in all areas. In addition, continuous cropping without soil test based fertilizer recommendation leads to the widespread nutrient deficiency in the soil and reduction in yield of crops. Fruit cracking, pest & disease incidence and poor withstanding capacity of crops under drought condition might be associated with nutrient deficiency and thus leads to 18-25 % reduction in yield of crops. Cowpea is leguminous crop, producing branches and lengthy vines to cover the entire surface of the soil. Leguminous crop fixes the atmospheric nitrogen, & improves the soil fertility also. With this preview banana-cowpea intercropping was introduced through KVK front line demonstration with ICM practice to farmers at DFI village since 2019 and same practice was continued by farmer and mean value was presented here under.

Materials and methods

To address the above problems, Krishi Vigyan Kendra, Namakkal, Tamil Nadu has conducted Front Line Demonstration (FLD) in 20 farmer's field in an area of 8 ha at DFI village - Ganganaickenpatti villages of Mohanur block with Poovan banana variety. The following interventions were included with ICM practice. Intercropping with cowpea seeds @ 15 kg ha^{-1} was sown in between banana plants and then Insitu incorporation of cowpea was done around the banana within 30-45 days after sowing of cowpea. Soil samples were collected at the time of planting, 15 days after incorporation of cowpea, and post harvest soil of banana. Adopted soil health card based fertilizer application through INM concept. Azospirillum @ 50 g/tree, phosphobacteria @ 50 g/tree, Vesicular Arbusicular Microrrhiza @ 250 g/tree and Trichoderma harzianum @ 50 g/tree were applied at the time of planting. Then azospirillum @ 20 g/tree & phosphobacteria @ 20 g/tree also again applied at five month after planting. Recommended Dose of Fertilizers Nitrogen : Phosphorus : Potassium @ 110:35:330 g/plants/year were applied. N &K applied in three equal splits at the 3,5,7 months after planting and P applied within 3 months after planting. Foliar spraying of 2% IIHR banana booster (Micronutrient formulation)

was given @ 3,5,7 months after planting. Need based plant protection measures were adopted throughout the cropping period.

Collected soil samples were studied for its soil properties as per standard procedures. pH and EC were determined in Soil : Water (1:2.5 ratio) extract by potentiometric and conductometric methods respectively (Jackson, 1973). Organic carbon was estimated by chromic acid wet digestion method (Walkley and Black, 1934). Available N in soil was estimated by alkaline permanganate method (Subbiah and Asija, 1956), available P by Colorimetry method (Olsen *et al*., 1954), available K by Neutral Normal Ammonium Acetate method (Stanford and English, 1949), available S by Turbidimetric method (Williams and Steinbergs, 1959) and available micronutrients Zn and B by colorimetric estimation using Mridaparikshak kit supplied by Nagarjuna Agro chemicals Pvt. Ltd., Hyderabad

Results and discussion

Soil properties

Soil pH was recorded neutral category (7.18 to 7.49), Electrical conductivity was non saline, organic carbon recorded from low to medium category, available nitrogen recoded lowest range, available phosphorus, available potassium and available sulphur recorded medium category, available zinc and available boron recorded in deficient category in soil samples collected from various growth stages of banana. Balanced fertilizer application based on the soil test values doesn't change the soil properties drastically from its initial properties.

By continuous adoption of scientific package of practices, fertility status increased from the Initial soil test values. Organic carbon content and available nitrogen was increased noticeably from 0.41 to 0.71 % and 210 to 239 kg ha^{-1} respectively, than other soil parameters and decreased to 0.51% and 227 kg ha^{-1} at harvesting phase (Table 1). The increase was 29 kg in available nitrogen and 0.30% in organic carbon observed in soil after incorporation of cowpea and content was reduced at harvesting whereas when compared to its initial value, still there was built up in OC & available N was observed.

Table 1. Effect of intercropping on nutrient status of soil

Parameters	Initial soil test value	KVK intervention (Demo)- After cowpea incorporation	Post harvest soil test values	
			KVK intervention (Demo)	Farmers practice (Check)
Soil reaction	7.18	7.49	7.32	7.35
Electrical Conductivity (dS m^{-1})	0.044	0.093	0.055	0.102
Organic carbon (%)	0.41	0.71	0.51	0.49
Available nitrogen (kg ha^{-1})	210	239	227	221
Available phosphorus (kg ha^{-1})	17.65	18.45	18.24	18.03
Available potassium (kg kg^{-1})	157	201	178	164
Available sulphur (mg kg^{-1})	12.02	12.60	12.26	12.09
Available zinc (mg kg^{-1})	0.99	1.13	1.04	1.01
Available boron (mg kg^{-1})	0.34	0.39	0.36	0.29

In addition to the improvement in growth and yield attributes, cultivating of cowpea as an intercrop in main banana, suppressed the weeds growth by its smothering effect by the production of length vines and spreading nature over the entire ground area completely for a period of 90 days. Also incorporated cowpea biomass, supplied enormous quantity of organic matter upon composting and it acts as a mulch in the soil was directly contributed in reducing the soil moisture evaporation, adds humus to the soil and supplies nutrients especially N, P and K for the growth of banana plants. Especially initial cowpea seed material used for sowing compensated through the addition of N to the soil by cowpea biomass. Also farmers pointed about increase in soil porosity and built up in earthworm's loads due to the cowpea mulch. This finding was also confirmed with the findings of Mool Chand Singh and Sairam (2016).

Application of biofertilizers along with recommended dose of inorganic fertilizers and cowpea intercropping increased the availability of nutrients in soil. Biofertilizers played a crucial role in increasing the nutrient availability by fixing atmospheric nitrogen, solubilises insoluble P,K and produces plant growth substances in soil. This helps to provide biotic and abiotic stress management in plants (Lenka and Lenka, 2014).

Effect of KVK intervention on growth attributes of banana

Phonological attributes like Pseudostem height was ranged from 267 to 285 cm, stem girth from 60.50 to 66.90 cm, no. of leaves per plant ranged from 24.1 to 25.9, leaf length from

139.3 to 143.1 cm and leaf width from 32.5 to 39.1 cm (Table 2). Similarly yield attributes was recorded more in KVK intervention. Higher yield attributes might be associated with higher phonological characteristics such as plant height, Pseudostem girth, number of leaves produced in the demo plants. Higher accumulation of carbohydrates due to more photosynthetic activity resulted in better growth and yield attributes. Jeyabaskaran *et al*. (2001) reported that proper supplement of nutrients through integrated approach supported well in phonological growth as well as yield attributing characteristics of poovan banana.

Proper supplements through soil test based fertilizer application increased the nutrient availability in soil which in turn increased the uptake of nutrients by crop which increased the growth and yield attributing characteristics of banana.

Yield attributes like Length of finger ranged from 12.1 to 13.8 cm, Finger girth was recorded 10.4 mm to 11.5 mm, finger weight from 92.1 g to 94.9 g, no. of hands/ bunch 10.4 to 11.5, no. of fingers/bunch 12.9 to 14.5, and bunch weight is 21.3 kg to 26.7 kg. Proper supplement of macro and micronutrients especially during critical growth stages increased the yield attributing characteristics and yield of banana. Increased bunch weight and yield could also observed due to more photosynthetic activity of plants. This was in accordance with the results of Patel *et al*. (2012) in banana. Cumulative effect of scientific package of practices stimulates the higher finger production, favour's finger development which ultimately leads to more bunch weight of banana. Also according to the findings of Akash Shukla *et al*., 2022, the increase in finger length and girth might be due to the better filling of the fruits and their growth with increased uptake of nutrients from soil which produced enough carbohydrates in the leaf for translocation to the sink for better filling of fruits.

Table 2. Growth and yield attributes of banana

Treatments	Pseudostem height (cm)	Pseudostem girth (cm)	No. of Leaves per plant	Leaf length (cm)	Leaf width (cm)	Length of finger (cm)	Finger girth (mm)	Finger weight (g)

KVK intervention (Demo)	285	66.9	25.9	143.1	39.1	13.8	11.5	94.9
Farmers practice (Check)	267	60.5	24.1	139.3	32.5	12.1	10.4	92.1
CD (P=0.05)	17.263	2.486	0.744	3.530	1.506	0.444	0.399	1.286

Effect of KVK intervention on yield attributes of banana

Yield & its attributes

Highest banana yield of 34.80 t ha^{-1} was recorded in the demo plot (KVK intervention from sowing to harvest) whereas farmers practice (check) recorded 30.20 t ha^{-1} (Tale 3). The demo yield proved its superiority by recording 15.07 % yield increase over check and having higher net return of Rs.1,89,543 with BC ratio 2.30 than check. Also recorded highest bunch weight 26.7 kg and no. of hands/bunch 11.5 in demonstration plot. Application of organics along with balanced nutrients improved the physical, chemical and biological properties of soil resulting in better supply of plant nutrients, which in turn led to good crop growth and yield. Presence of humus in organic produce increased activity of hydrolyzing and oxidizing enzymes which in turn facilitated the availability of nutrients to the root system. Thereby quick mobilization and availability of nutrients that would aid in increased phonological attributes and photosynthetic rate. This in turn would have assisted for the increased yield of banana. This is in confirmation with the findings of Patel *et al*. (2010) in banana. The higher banana yield obtained from these experiments also contributed by the suitable agronomic practices like intercropping with leguminous cover crops directly contributed to improvement of soil physical, chemical and biological properties by the release of humus in the soil and indirectly contributed by the controlling of weeds by its smothering effect of lengthy vines (Bauri *et al*., 2010).

Table 3. Yield and economics of banana

Treatments	No. of	No. of	Bunch	Yield	Cost of	Gross	Net	B:C

	hands/ bunch	fingers/bunch	weight (kg)	(t ha^{-1})	cultivation (Rs./ha)	income (Rs./ha)	income (Rs./ha)	ratio
KVK intervention (Demo)	11.5	14.5	26.7	34.8	145708	335251	189543	2.30
Farmers practice (Check)	10.4	12.9	21.3	30.2	132056	257893	125837	1.95
CD (P=0.05)	0.446	0.886	1.056	0.913				

Due to the improvement in growth and yield attributing characteristic of banana by adopting scientific package of practices, net return was achieved more in Rs.1,89,543/ha and BC ratio 2.30 in demo plot. This result was in accordance with the findings of Kuttimani, *et al*., 2013.

Farmers opined that intercropping with ICM practice improved the size of single fruit in the bunch, number of hands per bunch and over all bunch weight. Hence farmers fetched more price on an average of Rs. 37 /- to Rs.84/- per bunch. The technology more viable in increasing the yield of banana and hence farmers are being continuously adopted this technology Since 2019**.** The success of this technology being popularized in KVK routine training, regular advisories, farmer's group meetings and extension functionaries' programme.

Conclusion

After seeing the results, nearby 28 farmers started to grow cowpea as intercrop in banana to an extent of 37 ha. It arrests the weed growth and conserves the moisture from its losses. Hence farmer could save Rs. 6,500/ha per year per crop by skipping one weeding with agriculture labours. The expenditure incurred for purchase of seed material of cowpea used for intercropping could be met from amount of N added to the soil by cowpea insitu incorporation. With this, it can be concluded that growing of cowpea in banana along with nutrient

management practices resulted in improvement in soil fertility as well as yield of banana. Increase and built up in soil fertility was observed and economic status of the farmer (Rs.63,706/ha) improved by continuous adoption of this technology than conventional practice. Earthworms developed in the rhizosphere region without addition of vermicompost and introduction of worms to the field.

References

Akash Shukla, AK Dwivedi, VK Tripathi, Ravi Shankar Singh, Manoj Kumar and Jitendra Kumar Shukla.2022. Effect of INM on yield parameters of tissue cultured banana CV. Grand Naine under north Indian condition The Pharma Innovation Journal, 11 (4):1334-1336.

Bauri, F.K., S.K. Sarkar, B. Bandyopadhyay, D.K. Misra, S. Debnath and K. Chakraborti. (2010) Banana-cowpeaassociation in the perspective of weed management in banana plantation under new alluvial zone of West Bengal. Journal of Crop and Weed 6(2):72-750.

Jackson M L (1973). Soil Chemical Analysis. Prentice Hall of India Ltd., New Delhi.

Jeyabaskaran KJ, Pandey SD, Mustaffa MM, Sathiamoorthy S (2001) Effect of different organic manures with graded levels of inorganic fertilizers on ratoon of Poovan banana. South Indian Hort., 49:105–108.

Kuttimani, R., K. Velayudham, E. Somasundaram & P. Muthukrishnan. 2013. Effect of Integrated Nutrient Management on Yield and Economics of Banana. Global Journal Biology, Agriculture, and Health Studies.,Vol.2(4):191-195.

Lenka, J. and P. C. Lenka. 2014. Effect of integrated nutrient management on growth and yield of banana (Musa spp.) variety Grand Naine. Journal of Crop and Weed, 10(1):182-185.

Mool Chand Singh and C.V.Sairam.2016. Effect of spacing and intercropping with cowpea on weed growth in banana. International Journal of Science, Environment and Technology, 5 (2) : 558 – 563

Olsen S R,. Cole C V, Watanabe P S and Dean L A (1954). Estimation of available phosphorus in soils by extraction with sodium bicarbonate. U.S.D.A. Circ. 939.

Patel, C.M., Patel, N.L., Gaikwad, S.S. and Patil, S.J. 2010. Effect of post-shooting treatments on yield and it's attributes of banana (Musa paradisiaca L.) cv. Grand Naine. J. Plant Dis. Sci., 5(2): 210-212.

Stanford S and English L (1949). Use of Flame photometer in rapid soil test for K and Ca. *Agron. J.,* **41**: 446-447.

Subbiah B V and Asija G L (1956). A rapid procedure for estimation of available nitrogen in soils. *Curr. Sci.,* **65**: 477-480.

Walkley A and Black C A (1934). An examination of Degitijareff method for determining the organic matter and proposed modification of the chromic acid titration method. *Soil Sci.,* **37**: 29-38.

Williams C H and Steinbergs A (1959). Soil sulphur fractions as chemical indices of available sulphur in some Australian soils. *Aus. J. Agronomical Res.,* **10**: 340-352.