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Research Article

EVALUATING SIGNIFICANCE OF VERMICOMPOST AND INTERCROPPING *AMORPHOPHALLUS* FOR INTEGRATED INDIAN GOOSE BERRY ORCHARD MANAGEMENT

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Abstract- Integrated management of the orchard through intercropping vegetable crops and application of vermicompost or/and mustard cake is an effective approach to achieve high economic yield. This investigation was carried out to determine a suitable combination of inorganic fertilizers and vermicompost or/and mustard cake for intercropping Elephant Foot Yam (Suran) in Indian Goose Berry (Aonla) orchard. Greater reduction of soil pH (from 8.02 to 7.12) and maximum increase in organic matter (0.62% to 0.71%) was observed with T_9. T_8 (Aonla + Suran + 25% N_2 from Mustard cake + 25% N_2 from Vermicompost + 50% N_2 from Urea), T_9 (Aonla + Suran + 100% N_2 from Vermicompost) and T_{10} (Aonla + Suran + 100% N_2 from Mustard cake) were reported to be equally effective in improving available Nitrogen (197.86, 197.91 and 197.71 Kg/ha, respectively), available Phosphorus (25.58, 25.63 and 25.22 Kg/ha, respectively) and available Potassium (291.35, 292.45 and 290.41 kg/ha, respectively) in soil after 2 years of intercropping. However, significantly highest yield (62.31 q/ha) was reported in T_8 which was at par with other integrated treatments.

Keywords- Indian goose berry; Mustard cake; Organic Matter; soil pH; Vermicompost.

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Introduction

The integrated management of orchards through the suitable cropping system and organic nutrient sources has manifold advantages in terms of soil fertility and productivity enhancement and utilization of the economic potential of fruit crops [1]. Integrated orchard management includes, orchard floor management, canopy management, plant protection practices and bio-regulation of flowering and fruiting [Fig-1]. The orchard floor management through intercropping and organic supplements of nutrients is an economical and eco-friendly practice.

Intercropping of the vegetables in fruit crops provides additional income to farmers and helps in maximization of resource use. In addition to this it has a significant role in increasing the productivity and improvement of health of the orchards. Proper exploitation of the genetic potential of the different intercrops and proper utilization of interspaces available under the canopy of fruit plants are the basic principles of the intercropping in perennial fruit orchard. Among the different species of intercrops, growing tuber crops like elephant Foot Yam, *Colocassia*, Turmeric and Ginger have been reported to be suitable to perennial tree plantation. Suran, also known as elephant Foot Yam (*Amorphophallus companulatus* L.), is shade loving tuber crop, which has great potential to withstand and grow under canopy of fruit plants due to its very high photosynthetic efficiency and dry matter production through efficient solar energy transfer.

Another key aspect under an integrated system of orchard management is the nutrient management. In order to increase our production and productivity, we have used chemical fertilizers indiscriminately. The N: P: K consumption increased from 16798 thousand tones in 2003-04 to 28122 thousand tones in 2010-11 but have decreased to 25536 thousand tones in 2012-13 which was largely due to decrease in consumption of phosphorus and potassium and has intensified the ratio N: P: K consumption form 4.3:2.0:1 in 2009-10 to 8.2:3.2:1 in 2012-13 towards relatively high amount of nitrogen consumption (Department of Agriculture and Cooperation, 2014) [2]. The excessive use of fertilizers has now created another problem to the soil health of the orchard. Alarmed with the decline in the soil health and chemicalization of the modern day farming, greater emphasis on the integrated nutrient management (INM) system is being given in the recent years. Vermicompost has emerged as the best organic component of INM for soil improvement and maintaining the sustainability of Indian goose berry based agri-horti system [3]. The traditional organic manures and vermicompost release the nutrients slowly, hence the effect is exhibited not only on the instant crop, but also it remains for prolonged periods and thus has great significance for orchard management.

The integrated management of orchards through the suitable cropping system and organic nutrient sources has manifold advantages in improving the productivity, soil fertility and economic potential of fruit crops [4]. The integrated nutrient management system (INMS) is the integration of both biological as well as inorganic nutrient sources for soil health and sustainable agricultural production by ensuring synergistic and complementary interaction [5]. When inorganic fertilizers are supplemented with organic source's soil nutrient status is improved with increased availability of nutrients. Improvement of soil fertility is possible through the integrative application of nutrient sources with intercropping of legumes under perennial tree species [6-11]. Korwar et al. [12] had proposed improved level of soil nutrients which increased growth and yield of highest number of fruits. Buresh et al. [13] had proposed ISFM (Integrated Soil Fertility Management) paradigm to suggest complementarities between both, the organic as well as inorganic components of for sustainable soil management and agricultural production. Considering the significance of the integrated orchard management practices in

Indian goose berry the investigation was done to evaluate the influence of vermicompost and intercropping on soil nutrient status of Indian goose berry orchard.

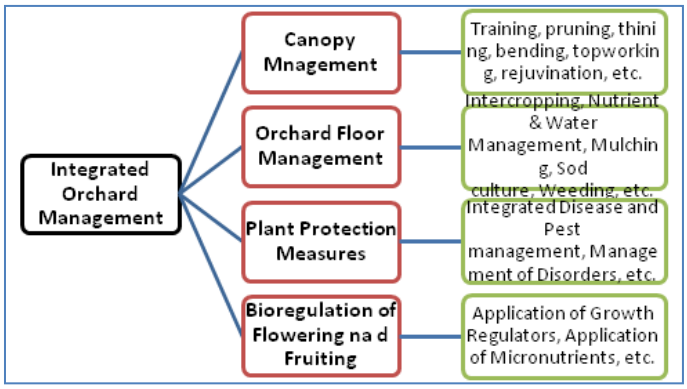

Fig-1 Components of Integrated Orchard Management

Materials and Methods

The investigation has been under taken at progressive farmer's field near Narendra Dev University of Agriculture and Technology, Narendra Nagar, Kumarganj, Faizabad (U.P.) during the year 2007-08 and 2008-09. The soil nutrient status of the experimental plot of aonla orchard was determined before taking the intercrops. The soil texture is silt clay-loam with sand: clay: silt in proportion of 1.42: 2.55: 1. The organic matter content of the soil was 0.62% with pH 8.02 while nitrogen, phosphorus and potassium content of the soil was 175.00, 22.50 and 270.00 Kg per hectare.Total experimental area was 2112 m^2 with 33 plots, gross area of each plot 56.24 m^2 and net area covered by intercrop in each plot was 53.10 m^2. Aonla trees were at spacing of 8m X 8 m and each plot had one centrally located plant. There were eleven treatments with three replications. The treatments are mentioned in [Table-1].

The cultural practices, adopted for aonla trees during the investigation, were based on the growth, flowering and fruiting behavior of the aonla trees. After harvesting the previous aonla crops in January, a light irrigation was given in the first week of February along with the application of the required dose of manure and fertilizers. Second manuring with light irrigation was provided in the last week of August for better fruit growth from mid-August to November and to reduce the fruit drop. The cultural practices adopted for cultivation of intercrops, had been tried to synchronize with the aonla trees in order to avoid any harmful impact on flowering and fruiting of aonla trees. The intercrop, *Amorphophallus*, was planted in each plot on February 25 by using corms of 200g weight at spacing 50 cm x 50 cm in pits of 45 cm x 45 cm x45 cm. Before planting, the corms were treated with Indofil M-45 (0.3%) for 20-30 minutes to protect them from infection by soil borne diseases. The well decomposed Farm Yard Manure @ 10 tones/ha was applied during the field preparation while N: P: K @ 40:30:50 (in kg/ha) was applied by different sources viz. urea, mustard cake vermicompost, SSP (Single Super Phosphate) and MOP (Meurrate of Potash) as per different treatments [Figure 2]. First irrigation was given after 25 days of planting and subsequently 3 irrigations were given at the interval of one month. The first weeding and earthing up was done after the first irrigation and second after one month of first weeding.

Table-1 *Influence of Intercropping and INM on Yield of Indian Gooseberry*

Treatments or Cropping Systems		Fruit Yield(q/ha)	
		2007-08	2008-09
T_1	Aonla + Suran + 100% N_2 from Urea	52.96	53.36^{c}
T_2	Aonla + Suran + 25% N_2 from Vermicompost + 75% N_2 from Urea	55.69	58.33^{b}
T_3	Aonla + Suran + 50% N_2 from Vermicompost + 50% N_2 from Urea	55.97	59.64^{ab}
T_4	Aonla + Suran + 75% N_2 from Vermicompost + 25% N_2 from Urea	55.42	60.55^{ab}
T_5	Aonla + Suran + 25% N_2 from Mustard cake + 75% N_2 from Urea	55.15	56.73^{bc}
T_6	Aonla + Suran + 50% N_2 from Mustard cake + 50% N_2 from Urea	54.60	57.10^{bc}
T_7	Aonla +Suran +75% N_2 from Mustard cake +25% N_2 from Urea	54.49	58.28^{b}
T_8	Aonla + Suran + 25% N_2 from Mustard cake + 25% N_2 from Vermicompost + 50% N_2 from Urea	56.24	62.31^{a}
T_9	Aonla + Suran + 100% N_2 from Vermicompost	54.16	56.82^{bc}
T_{10}	Aonla + Suran + 100% N_2 from Mustard cake	53.51	56.29^{bc}
T_{11}	Aonla alone as sole crop	52.42	51.37^{c}
Mean		54.601	57.34
SEm±		1.76	1.32
CD at 5%		5.19	3.89
		NS	S

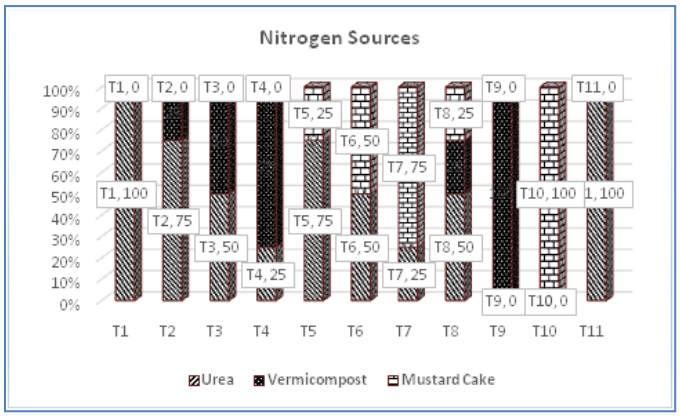

Fig-2 Proportion of Nitrogen from Urea, Vermicompost and Mustard Cake

Observation Recorded

The observations on various parameters of nutrient status of soil were recorded at proper stages of growth and maturity of both sole crop aonla and suran intercrops. The soil from four places was randomly collected by using the screw type auger from each plot and mixed together to get representative samples. The samples were dried in the oven at the temperature of 105^{0}C till the constant weight was obtained. Organic matter was estimated by "Rapid titration method" [14,15]. Soil pH was obtained with the help of a digital pH meter using 1:2.5 soil-water suspensions. Available nitrogen was determined by alkaline potassium permanganate ($KMnO_4$) as suggested by Subbiah and Asija [16] and Baruah and Barthakur [15]. Available phosphorus was estimated by Olsen's method available potassium was determined by flame photometer with the use of the saturation extract of soil as described by Baruah and Barthakur [15]. The yield was recorded by multiplying per plant yield recorded on harvesting by number of plants per hectare. The observations recorded on different aspects were statistically analyzed according to Gomez and Gomez [17].

Results and Discussion

The soil analysis was done for determination of nutrient status of soil due to the influence of intercropping of Suran under aonla plantation. The data recorded on soil analysis for O.M., pH, N, P, and K is presented in [Fig-3, 4 and 5], which clearly indicates that the pH ranged from 7.12 to 8.01, organic matter from 0.62% to 0.71%, nitrogen from 175.05 Kg to 197.91 Kg/ha, phosphorus from 22.56 Kg to

25.63 Kg/ha, and potassium from 270.72 Kg to 292.45 Kg/ha. It is apparent from the data recorded on nutrient levels of soil due to intercropping of suran and application of vermicompost that nutrients level were not much influenced in first year of intercropping while in second year significant effect was reported.

The data presented in [Fig-3] confirms that there was no any significant rise in soil organic matter during the first year of intercropping. However, significant rise in soil organic matter was reported in the second year due to application of vermicompost or/and mustard cake under different cropping systems. The significantly highest (0.71%) organic matter was reported in T_9 followed by T_4 (0.70%) and T_3 (0.70%). The findings can be confirmed by the findings of Biswas et al. [3] who had confirmed the increased soil organic carbon by 29% in five years of intercropping green gram and mustard in aonla-based agri-hort system when vermicompost was applied @ 2 tones/ha.

The present findings indicated that in 2007-08 the reduction in soil pH was highest in T_8 (up to 7.47), followed by T_3 (up to 7.55) and T_2 (up to 7.62), as compared to other intercropping systems; whereas, the highest soil pH was recorded in control i.e. mono-culture aonla [Fig-3]. In 2008-09, highest reduction (11.22%) in soil pH was reported in T_9 followed by T_4 (10.22%) and T_3 (9.35%) over the initial soil pH (8.02). Thus, intercropping of *Amorphophallus* had not significantly affected the soil pH and is in accordance with report proposed by Chadha et al. [18] who had advocated that the pH, conductivity and soil organic carbon were not significantly altered by berseem, chillies, cotton and peas intercrop. Reduction in soil pH after harvesting intercrops may be due to the addition of more organic matters through intercrops and the application of vermicompost and mustard cake, which promoted soil microbial activity by providing energy and nutrients, soil aggregation and buffering capacity of soil reaction [19].

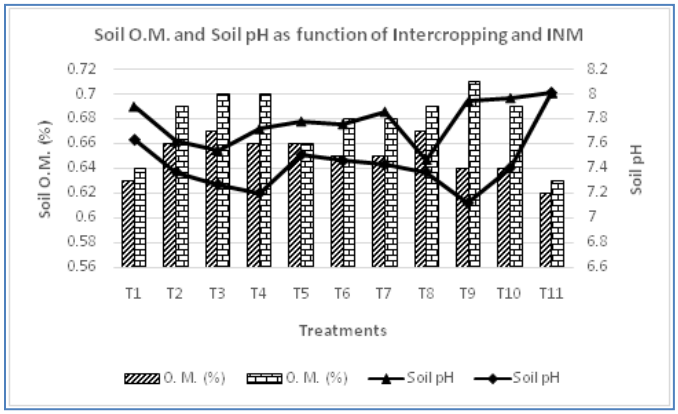

Fig-3 Influence of Intercropping and INM on Soil O.M. and Soil pH

Highest (188.49 Kg/ha) available nitrogen of soil [Fig-4] after harvesting the intercrops was estimated in T_8 followed by T_3 (187.58 Kg/ha) and T_2 (186.66 Kg/ha) in first year, while in second year the available nitrogen was significantly high in soils from plot supplied with vermicompost and mustard cake (T_9- 197.91, T_8- 197.86, T_{10}- 197.71, T_4- 196.23, T_3- 195.95, T_7- 195.00, T_6- 194.57, T_2- 194.03 and T_5- 193.00 Kg/ha) in comparison to T_1 (control) and T_{11} (Aonla sole crop). Thus, application of vermicompost and mustard cake had increased available nitrogen by 10.29% in T_5 to 13.09% in T_9 over initial available nitrogen (175 Kg/ha). Furthermore, increased available nitrogen was reported with increase in amount of applied vermicompost and mustard cake. However, the growing of tuber crops vegetables might be helpful in improving the soil texture and adding the organic matter by decomposing the foliage parts, which improve the available nitrogen content in soil. Increase in available nitrogen due to intercropping of cowpea and corn (non-leguminous crop) in cassava in an organic system was also reported by Devide*et al*. [20]. The highest soil organic carbon and available nitrogen due to application of vermicompost has been confirmed by Ramesh *et al.* [21].

The available phosphorus [Fig-4] and potassium [Fig-5] of soil showed non-significant variation due to intercropping however application of vermicompost or/and mustard cake had significantly improved phosphorus by 4.18% (T_5) to 13.91% (T_9) and potassium by 3.85% (T_5) to 8.32% (T_9) over 22.5 Kg/ha phosphorus and 270.00 Kg/ha potassium before intercropping. The increase in soil phosphorus and potassium might be due to the application of additional doses of fertilizers and less uptake of P and K by these intercrops. However, increasing levels of vermicompost or/and mustard cake also improved utilization of available phosphorus and potassium by aonla trees. The highest available K in case of supplementary application of organic components (vermicompost and mustard cake) with inorganic fertilizers in different treatments might be due to release of non-exchangeable K present in the soil and applied K through fertilizers which not only meet crop requirements but also build up available K content in soil. The present findings can be confirmed by findings of Laxminarayana and Patiram [22]; Saha*et al* [23] and Singh *et al* [24] in different cropping systems.

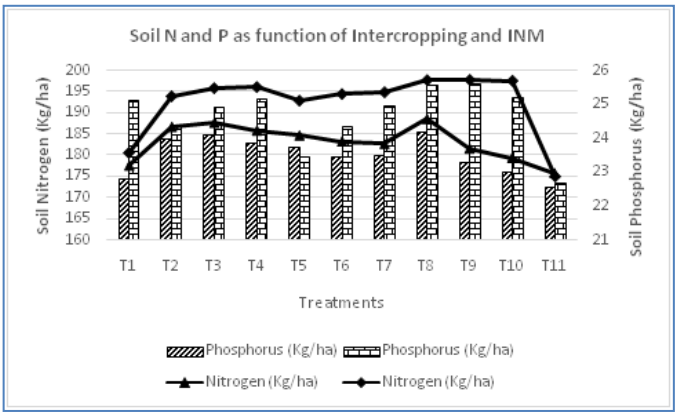

Fig-4 Influence of Intercropping and INM on Soil Nitrogen and Phosphorus

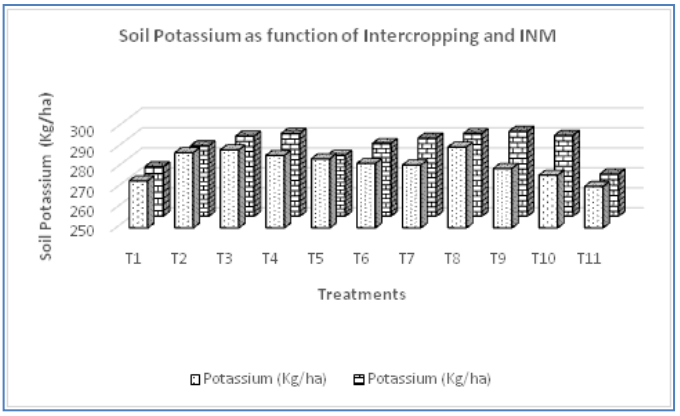

Fig-5 Influence of Intercropping and INM on Soil Potassium

The data presented in [Table-1] confirm that yield of aonla fruits was not affected by intercropping of *Amorphophallus* in the first year of intercropping whereas all treatments with the application of vermicompost or/and mustard cake had significantly increased the yield of aonla trees. Highest yield (62.31 q/ha) was reported in T_8 followed by T_4 (60.55 q/ha) and T_3 (59.64 q/ha). Increase in proportion of mustard cake or/and vermicompost had also resulted increase in yield of aonla which could be associated with improved absorption of nutrients from soil and their improved uptake by aonla trees in the presence of organic sources of nutrients. The increased nutrient uptake by application of bio-fertilizers in aonla as confirmed by Shashibala et al. [25]; Korwar et al [12]; Umar et al. [26] and Das et al. [27]. However, yield was reduced when 100% of nitrogen was supplied from either vermicompost (T_9) or mustard cake (T_{10}) which may be due to poor availability of nitrogen during the initial phase of the nitrogen requirement by aonla trees.

Conclusion

Intercropping of Elephant Foot Yam under canopy of Indian Goose Berry plantation and application of vermicompost or/and mustard cake for two years successfully increased nutrient level of soil. The most suitable combinations of nutrient sources were reported to be T_8(25% N_2 from Mustard cake + 25% N_2

from Vermicompost + 50% N_2 from Urea); T_3 (50% N_2 from Vermicompost + 50% N_2 from Urea); T_4 (75% N_2 from Vermicompost + 25% N_2 from Urea); T_2 (25% N_2 from Vermicompost + 75% N_2 from Urea); and T_7(75% N_2 from Mustard cake + 25% N_2 from Urea) as these treatments have resulted better yield.

Conflict of Interest: None declared

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