



ECONOMIC EVALUATION OF SOYBEAN IN DIFFERENT TREATMENTS LEVELS UNDER GUAVA BASED AGRI-HORTICULTURE SYSTEM IN VINDHYAN REGION OF UTTAR PRADESH, INDIA

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ABSTRACT

It is commonly recognized that agroforestry reduces the productivity of arable crops in the tropics and subtropics, but little is known about how different agroforestry systems affect agricultural yield. An investigation consisting of five treatments viz., T₁ (no fertilizer), T₂ (N: 20 kg, P₂O₅: 40 kg, K₂O: 30 kg, S: 10 kg ha⁻¹), T₃ (N: 30 kg, P₂O₅: 60 kg, K₂O: 40 kg, S: 20 kg ha⁻¹), T₄ (N: 40 kg, P₂O₅: 80 kg, K₂O: 50 kg, S: 30 kg ha⁻¹), T₅ (N: 50 kg, P₂O₅: 100 kg, K₂O: 60 kg, S: 40 kg ha⁻¹), respectively, and every treatment was replicated four times in Complete Randomized Block Design in a 12-year-old guava orchard. Results revealed that maximum cost of cultivation (Rs. 34544.08 ha⁻¹), gross return (Rs. 87773.09 ha⁻¹), net return (Rs. 53299.01 ha⁻¹) and B:C ratio (1.54) was found in T₅, whereas minimum was in T₁ (Control).

Key words : Agroforestry/Agri-horticulture, Benefit cost ratio, Economics, Intercropping, Guava, Soybean.

Introduction

The growing population is causing a rapid depletion of natural resources, such as land, water and vegetation in India as well as world. The situation is becoming more and more serious day by day due to the limited availability of fuel wood, food, fiber, and fodder. Now a day agriculture sector has become a risky enterprise due to low and irregular rainfall, low productivity and strong sun radiation, high-cost cultivation, and low returns in various arid and semiarid areas of the country. Over time, Agroforestry has proven to be a more effective method for improving agricultural output than monocropping (Johar *et al.*, 2017). Agroforestry strengthened conservation initiatives, promoted the recycling of organic waste, improved livelihoods through income diversification, and enhanced landscape aesthetics (Abdullahi and Anyaegbu, 2017). Agroforestry is a dynamic and sustainable method of managing land that involves planting woody perennials

and agricultural crops on farms in a way that encourages interactions between the crop and tree components. This creates a diverse, sustainable production system that benefits farmers both directly and indirectly. Fruit tree-based agroforestry system is one of the agroforestry systems that combine plants to improve productivity and supply fruits for household diets in the early stages and reduced the risk of total production losses. Agroforestry models based on fruit trees (mango, citrus, litchi, ber, pear, guava, etc.) are also gaining popularity because the forest tree component will be collected before the fruit trees begin to provide fruit for a living (Chauhan *et al.*, 2012). The agroforestry systems are more productive than sole agricultural systems as demonstrated by greater land-equivalent ratio (LER) (Yu *et al.*, 2015). In agri-horticulture system, horticultural plant species are integrated with agricultural crops, farmers receive a regular income in addition to the production from agricultural crops during the early stages of horticulture

tree establishment (Kaushik *et al.*, 2017).

Legumes have a significant role in improving soil fertility by fixing nitrogen biologically, increasing soil nutrient availability through pH reduction and facilitating better nutrient uptake by plants, which in turn influences production and improvement of soil quality (Awasarmal *et al.*, 2013; El-Mehy *et al.*, 2017). Soybean (*Glycin max* L.), a member of the Papilionaceae family, is regarded as the 20th century's "miracle crop" or "golden bean" due to its several uses (Khare *et al.*, 2016). Globally, soybean is cultivated as a pulse crop or as a well-known oil seed, is a great source of protein to add in your diet. According to Morshed *et al.* (2008), soybeans contain approximately 40-45% protein, 18–20% (Jahangir *et al.*, 2009), edible oil, 24–26% carbohydrates and 3.0-3.6% ash and a rich source of vitamins and minerals. Agri-horticulture system economic aspects are evaluated to monitor the system's economic effectiveness, highlight trade-offs between various advantages, and estimate financial needs and feasibility (Kareem *et al.*, 2016). So, present study conducted to evaluate the economics of soybean under different levels of fertilizer levels in guava based agri-horticulture system.

Materials and Methods

Study area

The studies were carried out at Agriculture Research Farm, Banaras Hindu University, Mirzapur (25 10' N Latitude 82 37' E Longitudes and at an Altitude of 427 meters above mean sea level.), Uttar Pradesh, India in 12-year-old- guava plantation. The climate of the study area was characterized as typically semi-arid, eastern plain zone agro-climatic zone III A. During the experimentation period the maximum temperature ranging from 41.3°C To 46.1°C during the month of March and May whereas, during the peak winter months of December and January the average minimum temperature falls up to 11°C. The site was characterised by mean annual rainfall was 975 mm during experimental period, out of which 90% were contributed through southwest monsoon between July to September.

Treatment details

Twelve-year-old plantation of guava (Allahabad safeda) were planted at the 7×7 m. in 2007 spacing, used as a horticulture tree. In the experiment, soybean variety, JS-2029 was seeded as intercrop under the plantation with 45×5 cm spacing with the seed rate of 80 kg ha⁻¹. The distance between plant to plant and row to row in soybean was maintained by thinning at 15 days after sowing (DAS). Prior to being sown into planting beds,

the seeds were treated with thiram and rhizobium culture at rates of 2 g/kg and 5 g/kg, respectively. The experiment was laid out in Randomised Complete Block Design with five treatment levels, contains four levels of nitrogen (N), phosphorus (P), potassium (K), sulphur (S) and a control (no fertilizer) were used and replicated four times. The five treatments includes T₁ Control (no fertilizer), T₂ (N:20 kg, P₂O₅:40 kg, K₂O:30 kg and S:10 kg ha⁻¹), T₃ (N:30 kg, P₂O₅:60 kg, K₂O:40 kg, and S:20 kg ha⁻¹), T₄ (N:40 kg, P₂O₅:80 kg, K₂O:50 kg, and S:30 kg ha⁻¹), T₅ (N:50 kg, P₂O₅:100 kg, K₂O:60 kg, S:40 kg ha⁻¹). The applications of doses of different fertilizers at the time of sowing were calculated per plot as per treatment, with the sources of fertilizers being Urea, DAP, MOP and elemental sulphur. The required package and practices were adopted from sowing to harvesting of crop. The entire crop was harvested after 90 days after sowing.

Economics

After harvesting of crop, to the evaluation of economic of system includes cost of cultivation (The expenses associated with the cultivation process comprised field preparation, seed sowing, weeding, material inputs like seed and fertilizer, and labour costs for various field tasks like crop harvesting and threshing). The prevailing market rates for fruits, grains, and straw were used to determine returns, along with the net return and benefit cost ratio were analysed.

Net return (Rs ha⁻¹) = Gross return (Rs ha⁻¹) – Cost of cultivation (Rs ha⁻¹)

$$\text{Benefit: cost ratio} = \frac{\text{Net return (Rs ha}^{-1}\text{)}}{\text{Cost of cultivation (Rs ha}^{-1}\text{)}}$$

Statistical analysis

An analysis of variance was performed using a standard statistical method on the data collected from different characters. The 'F' test, which measures variance ratio was used to determine significant effect of the treatments. Critical difference (C.D.) at 5% probability level was used to examine the difference in the treatment mean.

Results and Discussion

Physiochemical properties of soil

Analysis was done on the mechanical composition and initial physio-chemical characteristics. The mechanical composition was composed of 50.4% sand, 37.2% silt and 12.8% clay, in that order. Based on the examination, the soil was found to be slightly acidic (pH 6.1), with an electric conductivity of 0.18 dSm⁻¹, an organic carbon content of 0.39 %, medium in N (220.89 kg ha⁻¹),

available P (19.50 kg ha^{-1}) and available K ($266.56 \text{ kg ha}^{-1}$).

Effect of NPKS on yield attributes of soybean under guava based agri-horticulture system

As per the data analysis given in Fig. 2 showed that the highest seed yield ($1640.55 \text{ kg ha}^{-1}$) and straw yield ($2412.89 \text{ kg ha}^{-1}$), was obtained in the treatment (T_5) (50 kg N , $100 \text{ kg P}_2\text{O}_5$, $60 \text{ kg K}_2\text{O}$, and 40 kg S ha^{-1}), while lowest seed ($793.98 \text{ kg ha}^{-1}$) and straw yield ($825.80 \text{ kg ha}^{-1}$) was recorded in control (T_1). The increment in yield of seed and straw may be due to the increasing fertilizer levels because phosphorus regulates the sucrose/starch ratio in the source and the reproductive organs; thus, the stimulator effect of nitrogen, phosphorus, potassium and sulfur on growth and partitioning and photosynthesis to sink development has led to an increase yield attribute of soybean under guava based agri-horticulture system. Greater height and dry matter accumulation in the plant may have contributed to improved yield parameter and yield of soybean through better translocation of food to reserve in the sink. Khare *et al.* (2016) found that the yield of soybean was obtained maximum under subabul based agroforestry system with the application of (50% Farmyard Manure + 50% Vermicompost) than rest of the treatments. Similar trends of results were found by Bonde *et al.* (2017) that the combined application of fertilizers and FYM greatly improved yield of soybean, maximum was obtained with a 75% NP + 4t FYM + 25 kg S ha^{-1} . The same was concluded in a study conducted by Bachhav *et al.* (2012) that maximum seed yield and net return of Rs. $30,815 \text{ ha}^{-1}$ with B:C ratio 3.21 were obtained with the application of FYM + 100% RDF (*i.e.*, FYM @ 5 t ha^{-1} + 100% RDF) out of the rest of treatments. The variation in harvest index (%) was observed due to different levels of fertilizer N, P, K and S and *rhizobium* culture presented in Fig. 1. Highest harvest index (48.84) was recorded in (0 kg N , $0 \text{ kg P}_2\text{O}_5$, $0 \text{ kg K}_2\text{O}$ and 0 kg S ha^{-1}) while, lowest (40.48) in the treatment (50 kg N , $100 \text{ kg P}_2\text{O}_5$, $60 \text{ kg K}_2\text{O}$, and 40 kg S ha^{-1}).

Effect of NPKS on economic analysis of soybean under guava based agri-horticulture system

The effects of different treatments differed significantly in the gross return of the soybean crop, which in turn affected the overall net revenue and benefitcost ratio under guava based agri-horticulture system.

Cost of cultivation (Rs ha^{-1})

The average cultivation costs for various treatment combinations were calculated, considering every step of the process, from field preparation to the harvesting of

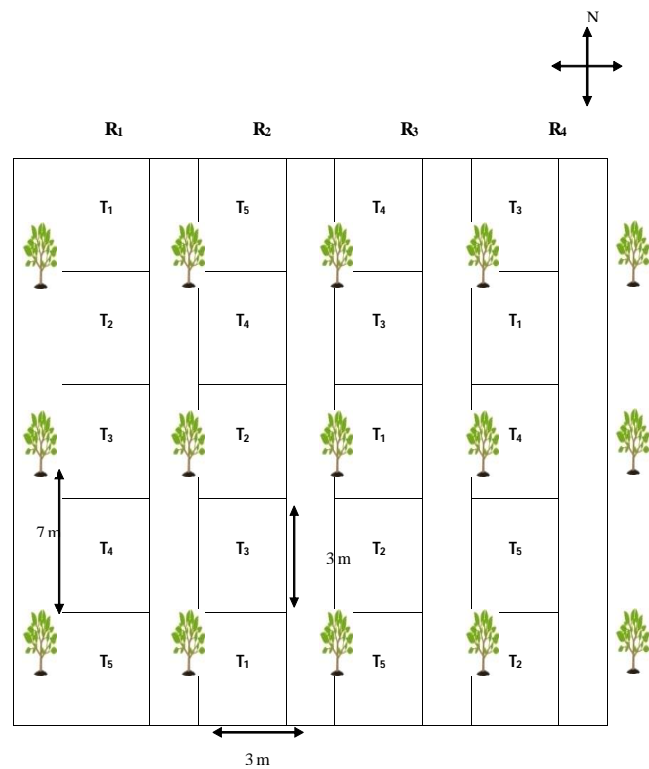


Fig. 1 : Layout of experimental area.

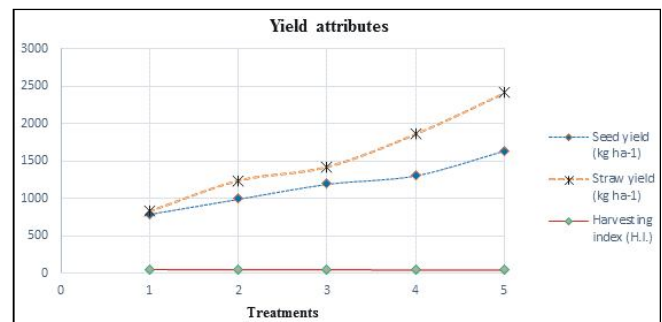


Fig. 2 : Effect of NPKS and on seed, straw and harvesting index of soybean under guava based agri-rhizobium horticulture system.

crop and input usage. The cost of cultivation may be varied from locations, availability of labour, and prices of fertilizer, seeds as per current market scenario. It was evident from the data that the treatment (T_5), which included 50 kg N , $100 \text{ kg P}_2\text{O}_5$, $60 \text{ kg K}_2\text{O}$ and 40 kg S ha^{-1} , was the maximum cultivation cost (34544.08 ha^{-1}) in all the treatments whereas the minimum cost of cultivation was recorded in T_1 (no fertilizer). Because of the higher labour and fertilizer input levels in T_5 , the cost of cultivation was highest there, whereas it was lowest in T_1 for the same factors.

Gross return (Rs ha^{-1})

The data presented in Table 1 shows that the application of (50 kg N , $100 \text{ kg P}_2\text{O}_5$, $60 \text{ kg K}_2\text{O}$, and 40 kg S ha^{-1}) in (T_5) produced the highest gross return

Table 1 : Effect of NPKS on relative economics of soybean under guava based agri-horti system.

Treatment	Total cost (Rs ha ⁻¹)	Seed return (Rs ha ⁻¹)	Straw return (Rs ha ⁻¹)	Guava return (Rs ha ⁻¹)	Gross return (Rs ha ⁻¹)	Net return (Rs ha ⁻¹)	B:C
T ₁ Absolute control	24710	26987.21	2477.39	24772.13	54236.73	29526.73	1.19
T ₂ N,P ₂ O ₅ ,K ₂ O,S (20,40,30,10)	28052	33831.44	3713.09	24772.13	62316.66	34264.66	1.22
T ₃ N,P ₂ O ₅ ,K ₂ O,S (30,60,40,20)	30321.78	40652.04	4267.50	24772.13	69691.67	39369.89	1.30
T ₄ N,P ₂ O ₅ ,K ₂ O,S (40,80,50,30)	32432.64	44518.57	5589.68	24772.13	74880.38	42447.74	1.31
T ₅ N,P ₂ O ₅ ,K ₂ O,S (50,100,60,40)	34544.08	55762.29	7238.67	24772.13	87773.09	53229.01	1.54

(87773.09 ha⁻¹) among all the fertilizer levels. Control variables (T₁) being 0 kg N, 0 kg P₂O₅, 0 kg K₂O and 0 kg S ha⁻¹ had the lowest gross return (54236.73 ha⁻¹). The gross monetary return of soybean varied with applied treatment levels because the applied treatment has also shown variation due to the cost of input variables.

Net return (Rs ha⁻¹)

The data on net return as affected by different fertility levels are presented in Table 1. The data revealed that net return was markedly influenced by different cost incurred and yield (grain+ straw) obtained under various treatments. The maximum net return (53299.01 ha⁻¹) was observed by application of (50 kg N, 100 kg P₂O₅, 60kg K₂O and 40 kg S ha⁻¹) in (T₅) and the minimum with control (0 kg N, 0 kg P₂O₅, 0kg K₂O and 0kg S ha⁻¹) in (T₁). The value was (29526.73 ha⁻¹). The higher net return was obtained in (T₅) due to the higher production of yield attributes, may be due to the higher input levels as compare to control (T₁) (no fertilizer). Similarly, Palsaniya *et al.* (2012) showed that the maximum net return was obtained from the guava and barley based agri-horticulture system (Rs. 41,063 ha⁻¹) as compared to sole cropping system (Rs. 6,802 ha⁻¹). In an experiment, Banerjee and Dhara (2011) found that among the different agroforestry system maximum total outturn (Rs.71,028 ha⁻¹) found in *A. auriculiformis* + sweet orange + Bottle gourd based agri-horticulture system as compared to sole cropping system. In an agri-horticultural system based on custard apples and an alley cropping pattern on Vindhyan soil, Chandrakar *et al.* (2014) investigated the effects of varying fertilizer levels on the growth and production of rainfed black gram. The 100% RDF + 25 kg zinc sulphate instance showed the maximum net return of Rs. 18143 ha⁻¹ under the alley cropping with black gram.

Benefit cost ratio

Variations in the costs incurred and the yield (straw and grain) obtained under different treatments had a significant impact on the net return. The data on benefit: cost ratio was presented in Table 1, which indicates that maximum benefit: cost ratio (1.54) was recorded with the application of 50 kg N, 100kg P₂O₅, 60 kg K₂O and 40 kg S ha⁻¹ in (T₅), whereas minimum benefit: cost ratio (1.19) was recorded under 0 kg N, 0 kg P₂O₅, 0 kg K₂O and 0 kg S ha⁻¹ in (T₁). Due to the higher net return rate of both (soybean+ guava), T₅ gave the highest benefit cost ratio as compared to rest of the treatments. Whereas the lowest benefit cost ratio was obtained in T₁. An experiment conducted by Kaushik *et al.* (2017) found that the cluster bean–barley agri–silvi–horti system with khejri + guava has highest (1.80) B:C ratio as compared to other treatment levels. The similar trends of results were found by Dev *et al.* (2017) reveals that compared to sole sesame cultivation (1.43), the B : C ratio (2.83) under the bamboo + sesame agroforestry system was higher than the rest of treatments. Likewise, Thakur *et al.* (2017) found that in an agroforestry system, T₅(100% FYM) produced the highest net returns (Rs 207711.82 ha⁻¹) and the B:C ratio (2.68).

Conclusion

Economic evaluation of agri-horticulture systems is essential due to continuous increasing pressure on agriculture sector and land productivity of cropping system. Based on findings it can be conclude that soybean (JS 20–29) with (50 kg N, 100 kg P₂O₅, 60 kg K₂O and 40 kg S ha⁻¹) significantly increased seed yield (1640.55 kg ha⁻¹) and straw yield (2412.89 kg ha⁻¹), as well as the maximum gross return (87773.09 ha⁻¹), net return of (53229.01 ha⁻¹) and benefit:cost ratio (1.54), whereas the lowest was observed in the control under guava based agri-horticulture system in Vindhyan region.

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