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Performance of different aonla based intercropping systems for marginal land in rainfed areas of Jharkhand (India)



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ABSTRACT

Sustainability and profitability of farming systems, particularly of marginal and small holdings facing serious challenges due to declining trend of per capita low availability and shrinking size of operational holdings. Natural resources of the country are having more and more pressure due to burgeoning population, which also requires more food, fodder, fuel, water, etc. A field study on standardization of sustainable and profitable alternate land use (Horti-agri) system for marginal land in rainfed areas of India was carried out at ZRS, Chianki (B.A.U., Ranchi, Jharkhand, India) to increase productivity and profitability of the marginal farmers during 2018 and 2019 in a well-established aonla (*Emblica officinalis* Gaertn.; cv. NA-7) orchard under rainfed conditions. The results revealed that all the cropping sequences intercropped with aonla exhibited higher aonla equivalent yield and net returns over the sole cropping. The aonla- aerobic rice horti-agri system exhibited the highest aonla equivalent yield (9.6 t ha^{-1}), and net return (Rupee 114000/- ha^{-1}), followed by the aonla- black gram horti-agri system, which registered aonla equivalent yield of 8.3 t ha^{-1} and net return of Rupee 110000/- ha^{-1} , and both horti-agri systems were statistically at par with each other. The study also revealed that the yield of aonla fruit was non-significant in all horti-agri systems. Thus, it is inferred that aonla- aerobic rice or aonla- black gram horti-agri system may be recommended for realizing higher productivity and net returns. The interspaces of the aonla orchard in the marginal land of rainfed areas could be utilized for growing various intercrops to generate substantial additional income without adverse effect on the productivity of the main crop.

Keywords: Aonla, drought, economic analysis.

INTRODUCTION

A study carried out regarding drought characteristics of rainfed areas of Jharkhand (India) revealed that there is a decreasing trend in the rainfall pattern. The recent mean decennial rainfall has decreased drastically. It has reached from 1304.4 mm (1961-85) to 830.4 mm (2001-10). The study revealed that there is a possibility of one drought year in a span of five years. In the last twenty years, the frequency of drought years has been more than that of the previous thirty years. This is a remarkable change. Analysis showed that the percentage of drought, normal and abnormal years was 20 %, 60 %, and 20 % respectively (5).

The study revealed that there was an increase in the total no. of drought months during the last twenty-five years in comparison to the previous twenty-five years. The increase in frequency of drought months was also observed during both the Kharif (June to September) and the Rabi season (October to February). There was an 83% increase in drought months during the Kharif Season of the last twenty-five years (12 nos..) over the previous twenty-five years (22 nos..). The frequency of monthly drought also increased in all months except February, April and December.

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There was a remarkable change in the drought frequency of September. There was a 250 % increase in drought frequency during September. The increase in drought frequency during September may adversely affect rainfed crops, as most of the crops will be at the flowering to yield formation stage (5).

In these circumstances, alternate land use (Horti-agri system) may play a vital role for marginal land farmers to increase productivity, profitability, as well as sustainability.

Further, the ever-increasing population has put tremendous pressure on agricultural lands, with the result that even the marginal lands of rainfed areas are put under cultivation. Developing a sustainable farming system in the rainfed areas is a challenge because it is characterized by sparse and highly variable rainfall, extreme variation of diurnal and annual temperature and high evaporation. Shortage of rainfall results in partial or complete failure of the crop production, thereby the region experiences frequent drought, which directly affects the livelihood of the inhabitants of the region. Therefore, crop production alone is inadequate to sustain the livelihood in the region. Integration of arable crop production with perennial components like fruit crops can play a pivotal role not only to provide assured production and income during adverse conditions, but also it largely contribute to the improvement of soil fertility, microclimate modernization and moisture availability to the inter-spaced grown crops. Under such a situation, alternate land use may be a viable option. When land is put under an alternative production system in order to match its capability more appropriately to the new land use and achieve more sustainable biological and economic productivity

in the long term, it is known as alternative land use (4). In rainfed areas, growing trees along with crops or at bunds/fences could help to provide insurance against climatic extremes. Shrubs and trees could provide food, fodder and fuel wood, windbreaks and live fences, and reduce runoff, evaporation and soil erosion. The different alternate land use systems may be the most important solution towards sustainable development in developing countries, as they can be used to address three important problems associated, *viz.*, low production, soil erosion and fuel wood. Integration of seasonal crops with fruit trees is a viable approach for enhancing system productivity (6). Intercropping of arable crops with fruit trees helps in minimizing the risk for farmers in the event of adverse climatic conditions (2).

Fruit trees suitable for cultivation under such climatic aberrations with vagaries of monsoon may increase the production potential of marginal land as compared to the traditional farming system. In this context, aonla or Indian gooseberry (*Embllica officinalis* Gaertn.) - based agri-horticultural system has immense potential to utilize and conserve rainfed areas for the betterment of resource-poor farmers. Alternate land use systems, particularly horti-agri systems with the inclusion of aonla (*Embllica officinalis*) on marginal and less productive soils, have tremendous potential in the region. Besides having a nutritional and medicinal value, cultivation of aonla is remunerative for small and marginal farmers (1).

Aonla, being a deep-rooted deciduous tree species, has a wide range of adaptability to grow in any type of soil. It is considered a highly tolerant and potential fruit species suitable for growing under salt-affected and wasteland/ravine lands. Aonla provides higher economic returns with little investment in plantation establishment and its management. Cultivation of agricultural crops with aonla provides an opportunity for maximum use of the land surface and helps to distribute the risk due to adverse climate. The tree canopy of aonla with sparse foliage allows filtered light and permits intercropping even after the trees are fully grown. Intercropping not only generates an extra income, but also helps check soil erosion through ground coverage and improves the soil physico-chemical condition. Traditionally, intercropping in the interspaces of fruit orchards is practiced due to economic considerations, but only a few experimental results are available for aonla-based horti-pastoral and horticultural systems. Keeping this in view, a study was undertaken to find out the performance of different aonla-based intercropping system

for marginal land in rainfed areas of Jharkhand (India)

MATERIALS AND METHODS

A field experiment was conducted at the research farm of Zonal Research Station, Chianki, situated at 23° N and 84.2° E under the jurisdiction of Birsa Agricultural University (Ranchi), Jharkhand, India, during 2018 and 2019. The soil of the experimental field was sandy loam in texture with a pH of 7.4. The soil of the experimental site was medium in organic carbon (0.53%), available nitrogen (252.1 kg ha⁻¹), phosphorus (67.9 kg ha⁻¹) and low in available potassium (114.0 kg ha⁻¹). There was a total of nine treatments comprising Aonla + urd, Aonla + aerobic rice, Aonla + maize, Aonla + sesame, sole aonla, sole urd, sole aerobic rice, sole maize and sole sesame. The experiment was laid out in a randomized block design with five replications, and each replication consisted of five aonla trees. Aonla trees and intercrops were also raised as sole crops for comparison. The trial was made in a well-established aonla orchard of cv. NA-7.

The intercrops were sown 1 m away from the trunk in the interspace (4 m x 4 m) left between the trees. Intercrops were sown in the third week of June during the study years. All the recommended packages and practices were followed to grow all Arable crops and fruit crops.

Marketable produce of intercrops and main crop (aonla) in terms of per hectare and their saleable value was worked out. The economics was calculated by considering the actual expenditure incurred on various operations, prevailing labour charges and the current price of inputs and value of produce in the market. The net returns were computed taking into account market rates of crops.

RESULTS AND DISCUSSION

Yield of aonla and arable crops

There was no significant effect on the yield attributing parameters of the crops grown either as sole or intercrop. However, the grain yield obtained in the intercropping system was lower than that of sole cropping. More yield of aonla fruit (7.0 t/ha) was recorded in the sole aonla, followed by aonla + black gram (6.9 t/ha) and aonla + aerobic rice (6.9 t/ha). The study revealed that the yield of aonla fruit was non-significant in all horti-agri systems.

The yield of arable crops was significantly influenced when grown in association with aonla fruit trees and in open space. All the arable crops resulted in the higher grain yield when grown in open space, followed by in association with aonla fruit tree (Table 1). Among the arable crops, the highest aonla equivalent yield was exhibited by aerobic rice (9.3 t ha⁻¹) followed by black gram (8.6 t ha⁻¹), with aonla and in open space. The yield of aerobic rice and black gram was 3.3 t ha⁻¹ and 0.59 t ha⁻¹ in open space, respectively. All the arable crops resulted in lower grain yield when grown in association with aonla (Table 1). More yield of arable crops was obtained when grown in open space, and it might be due to no competition from other plants except competition within the same species, which results in easy availability of solar radiation, air, nutrients and moisture to the crops, which could help in proper growth and development. Almost similar results were reported by (2).

Economics of systems, Rain water use efficiency (RWUE) and Land Equivalent Ratio (LER)

The economic analysis of different horti-agri systems revealed that, gross return, net return and benefit cost ratio (BCR) were influenced by different horti-agri systems. All the horti-agri systems showed higher economic return than sole aonla or sole arable crops.

The system resulted in maximum utilization of land area, making maximum use of the rainwater. The land equivalent ratio was maximum when aonla was intercropped with blackgram (1.96), followed by aonla-aerobic rice horti-agri system (1.95), and least with aonla-sesame system (1.86). Similar findings were reported by (3) in the Custard apple. The study showed that intercrops did not exert an adverse effect on the yield of aonla.

The aonla- aerobic rice horti-agri system exhibited the highest net return (Rupee 114000/- ha⁻¹) followed by the aonla- black gram horti-agri system, which registered a net return of Rupee 110000/- ha⁻¹, and both horti-agri systems were statistically at par with each other.

Table 1: Influence of intercropping on yield, net returns and rain water use efficiency in horti-agri systems

Treatments	Aonla Fruit yield (t ha ⁻¹)	Yield of arable crops (t ha ⁻¹)	Aonla equivalent yield (t ha ⁻¹)	Net returns (Rupee ha ⁻¹)	RWUE (kg/mm)	LER	Plant height		No. of fruits/tillers/cob/capsules/pods per plant	
							Aonla (m)	Arable crop (cm)	Aonla	Arable crop
Aonla + black gram	6.9	0.59	8.6	110000.0	8.15	1.96	5.10	30.8	3459	8.4
Aonla + aerobic rice	6.9	3.42	9.3	114000.0	8.99	1.95	4.94	103.1	3463	14.1
Aonla + maize	6.5	4.46	7.0	65000.0	7.32	1.88	5.00	146.3	3440	1.2
Aonla + sesame	6.7	0.32	7.8	94000.0	9.72	1.86	5.00	105.8	3450	66.5
Sole aonla	7.0	-	-	90000.0	7.32	1.0	5.15	-	3470	-
Sole black gram	-	0.62	1.6	17040.0	1.67	1.0	-	31.9	-	8.9
Sole aerobic rice	-	3.50	2.3	22200.0	2.40	1.0	-	105.0	--	14.3
Sole maize	-	4.60	3.7	50820.0	3.86	1.0	-	148.7	-	1.2
Sole sesame	-	0.35	0.9	7996.0	0.94	1.0	-	109.0	-	66.8
CD (5 %)	NS	1.29	0.82	7216.01	1.64	1.28	-	-	-	-
CV (%)	10.84	12.24	14.25	12.64	14.21	13.8	-	-	-	-

Conclusion

From the present study, it is inferred that aonla- aerobic rice or aonla- black gram horti-agri system may be recommended for realizing higher productivity and net returns. The interspaces of the aonla orchard in the marginal land of rainfed areas could be utilized for growing various intercrops to generate substantial additional income without adverse effect on the productivity of the main crop.

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