International Journal of Horticulture, Agriculture and Food Science (IJHAF)
ISSN: 2456-8635
[Vol-6, Issue-3, May-Jun, 2022]
Issue DOI: https://dx.doi.org/10.22161/ijhaf.6.3
Article DOI: https://dx.doi.org/10.22161/ijhaf.6.3.2

Early growth performance of Aonla based agroforestry in Eastern U. P.

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Received: 20 Apr 2022; Received in revised form: 19 May 2022; Accepted: 25 May 2022; Available online:31 May 2022

Abstract— *This study is outcome of performance of varieties of Aonla with intercropping of mustard in horti-agri system. Agroforestry models were established with Aonla var. NA- 6 (Amrit), NA- 7 (Neelam) and NA- 10 (Balwant) and Chakaiya in Randomized Block Design at 8 x 8 m with 11 treatments at Krishi Vigyan Kendra, Ballia. The soil at the site is alkaline in nature with 8.30 pH , medium Phosphorus , low nitrogen & potassium and low organic carbon. It was found that change in girth at breast height was highest (3.09 and 5.46 cm) for T_3 (NA - 10 + Mustard) followed by other varieties viz. T_5 (NA-7 + Mustard) 2.75 and 5.07 cm, T_7 (Chakaiya + Mustard) 2.63 and 4.90 cm. The least increment in girth was 2.16 and 3.09 cm for T_{10} (Desi/Biju Aonla) respectively. The increment in height after one & two years depicts that treatment T_3 (NA-10 + Mustard) are performing superior (0.52 and 1.17 m) followed by T_5 (NA-7 + Mustard) with 0.50 and 1.73m and T_7 (Chakaiya + Mustard) with 0.34 and 1.56 m whereas T_{10} (Desi/Biju Aonla) has lowest values (0.25 and 0.93 m). On the basis of preliminary growth data of increment in height and girth/Cc data trends, T_3 (NA-10 + Mustard) is performing superior over others after two year of planting. The evaluation of intercrops showed that higher returns were obtained when the intercrops were grown with Aonla compared to sole crops. The intercropping of Mustard in Aonla based agroforestry revealed that highest (13.51 qt /ha) crop yield was recorded with T_3 (NA-10+ Mustard) variety followed by almost similar values with other varieties whereas the sole mustard crop gave lowest yield with 11.33 qt/ha.*

Keywords— ***Aonla, agri-horti system, intercropping, mustard, growth performance.***

I. INTRODUCTION

Conventional farming is proved all over the world with the cultivation of crops which is nothing but a type of mixed cropping or intercropping [1]. The agriculture systems of old periods in different parts of world have crop mixtures which were used by the society for a long time [2]. The agroforestry system is most conventional practices and has immense role in reducing receptiveness and increasing flexibility of farming systems [3], but there are challenges that bring in the benefits of agroforestry in India. Therefore, a managing system needs to be designed that is well-sufficient in producing food from marginal agricultural land and is also able of maintaining and improving value of producing environment [4]. There is shortage of better-quality planting material and improved seed varieties. The difference is emerged in terms of diversity in agroforestry practices, and relative benefit provoked a changed interest to connect the vibrant prospective [5]. Suitable crop combinations under orchard during early phases can produce additional income, improved output and better ecological situation [6] . Fruit based cropping system is now well thought-out to be the most ideal strategy to provide food, nutrition and income security for the people [7, 8, 9]. Incorporation of annual crops with fruit trees yield multiple outputs that make certain production and income generation [10,11] .The acceptance of high-intensity cropping systems may be the practical alternative to increase agricultural output and production [12, 13]. Despite of adaptability of Aonla, production and economic returns of the crop are affected by low temperature and frost [14, 15]. Aonla or Indian gooseberry (*Emblica officinalis* or *Phyllanthus emblica*) based agri-horticultural system and silvi-agri systems have immense potential to utilize the available land spaces for

economic sustainability. Therefore, a study has been carried out for assessing early growth performance of Aonla with mustard based agri-horti system in Ballia district of Eastern Uttar Pradesh.

II. MATERIALS AND METHODS

Study Area: The district Ballia is situated in eastern region of Uttar Pradesh. It has an unevenly shaped tract extending from the convergence of the Ganga and the Ghaghra rivers, separating it from Bihar. The border between Ballia and Bihar is determined by the streams of these rivers. It is surrounded by Mau, Deoria and Ghazipur. The district occupies parallels of 25º33' and 26º11' North latitudes and 83º38' and 84º39' East longitudes. Seventeen blocks with 2372 number of villages are located in the district. It is with lowest forest covered districts in India (0.74 %) as per FSI report 2019 [16].

Fig. 1 District map of Ballia

Establishment of experimental trial: The field trial was established in August 2019 in Ballia district on selected sites at Krishi Vigyan Kendra located in village - Sohaon in Sohaon development block. The Aonla based agroforestry trial was established with CRBD with three replications , 8 X 8 m spacing and 11 treatments *viz.* T_1 (NA-6 + Mustard), T_2 (NA -6 Control), T_3 (NA- 10 + Mustard), T_4 (NA -10 Control), T_5 (NA -7 + Mustard), T_6 (NA-7 Control), T_7 (Chakaiya + Mustard), T_8 (Chakaiya Control),T_9 (Desi/Biju + Mustard) , T_{10} (Desi/Biju Control), T_{11} (Mustard) for Aonla (NA- 6 Amrit, NA- 7 Neelam , NA- 10 Balwant and Chakaiya *var.*) . The 100 g NPK (3:2:1) and FYM (1 Kg/plant) fertilizers were used to help in establishment of growth. The annual growth of Aonla tree was recorded for growth parameters *viz*. girth at breast height/collar circumference and height and annual increments were calculated.

Soil analysis : Soil analysis [17] of selected site was done by following standard methodologies for pH (8.2), EC (0.74 mm/cm), OC (0.51 %), Available N (189.25 kg/ha), Available P (11.25 kg/ha) and Available K (212.50 kg/ha).

III. RESULTS AND DISCUSSION

Performance of Aonla in experimental trial:

Plant height of Aonla increased significantly with age in intercrop combination of Mustard. However, the increase was pronounced when grown in association with Mustard crop rotations as compared to its sole plantation. The data were recorded for growth parameters (annual increment in height and girth/collar circumference) at annual interval for experimental trial. In Table 1, early growth performance of Aonla in Aonla – Mustard agroforestry has been depicted. It was found that increment in girth after one & two year of planting was highest (3.09 and 5.46 cm) for T_3 (NA - 10 + Mustard) followed by other varieties viz. T_5 (NA-7 + Mustard) 2.75 and 5.07 cm, T_7 (Chakaiya + Mustard) 2.63 and 4.90 cm. The least increment in girth was 2.16 and 3.09 cm for T_{10} (Desi/Biju Aonla) respectively. The increment in height after one & two years depicts that treatment T_3 (NA-10 + Mustard) are performing superior (0.52 and 1.17 m) followed by T_5 (NA-7 + Mustard) with 0.50 and 1.73m and T_7 (Chakaiya + Mustard) with 0.34 and 1.56 m whereas T_{10} (Desi/Biju Aonla) has lowest values (0.25 and 0.93 m). On the basis of preliminary growth data of increment in height and girth/Cc data trends, T_3 (NA-10 + Mustard) is performing superior over others after two year of planting (Fig. 2 a & b). The superior growth of Aonla plants with association of intercrops may be attributed to the better response of inputs applied to the intercrop.

Table 1 Growth performance of Aonla after two years of planting under Agroforestry

Treatment	Increment in girth/Cc (cm)		Increment in height (m)	
	After 01 year	After 02 year	After 01 year	After 02 year
T_1	2.18	4.01	0.52	1.17
T_2	2.40	4.04	0.49	1.08
T_3	3.09	5.46	0.52	1.81
T_4	2.89	4.13	0.46	1.19
T_5	2.73	5.07	0.50	1.73
T_6	2.74	4.09	0.45	1.50
T_7	2.63	4.90	0.34	1.56
T_8	2.51	4.35	0.37	1.15
T_9	2.30	3.13	0.29	1.02
T_{10}	2.16	3.09	0.25	0.93
SE(m)	0.15	0.11	0.32	0.05
CD (5%)	0.43	0.33	0.97	0.16

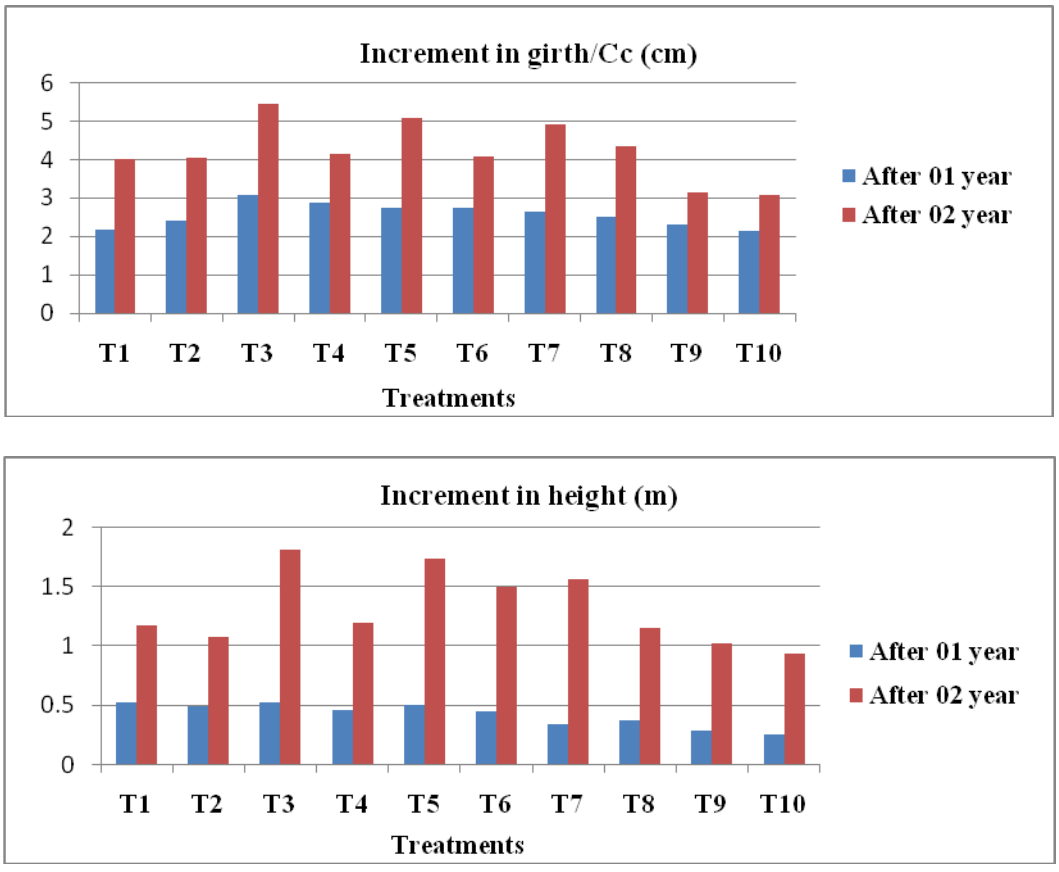

Fig: 2 (a, b): Growth performance (girth & height) of Aonla after two year of planting

Performance of intercrop:

The Intercrop Mustard grown with Aonla has not recommended significant competition on early performance of Aonla trees which may be due to different rooting behaviour of the Aonla and intercrop. The returns of the intercrop in association with Aonla and sole crops are given in Table 2 & Fig. 3. The economic evaluation of cropping system depicted that better yields were found when the intercrops were grown in combination with Aonla rather than sole cropping. The intercropping of

Mustard in Aonla based agroforestry revealed that highest (13.51 qt. /ha) crop yield was recorded with T_3 (NA-10+ Mustard) variety followed by almost similar values with other varieties whereas the sole mustard crop gave lowest yield with 11.33 qt/ha. It could be concluded that intercrops did not exert much significant competition neither on the growth and development of Aonla nor the productivity of intercrop was affected by Aonla in early stages of plantation.

The significant differences in production levels of perennial as well as ground storey components in multi species cropping models was recorded as compared to sole cropping [18]. Economic analysis of different cropping system depicted that higher returns were gained when the intercrops were grown in combination with Aonla instead of sole crops. Similar results have been reported in Ber & Aonla [19] and in Khejri-based cropping system [20]. The improved returns from tree-crop combinations have also been reported in perennial fruit-based multi-storied production system [21] .

Intercrops grown in combination with Aonla did not propose much competition on annual growth and development of Aonla which may be due to different rooting behaviour of the Aonla and intercrops. Similar effects of intercropping with leguminous crops (green gram, black gram, and cowpea) on vegetative growth of Aonla have been reported [22]. The findings also support the views in Ber (*Zizyphus mauritiana* Lam.) [23] and in Mango (*Mangifera indica* L.) where positive effect of intercrops on growth of trees [24].

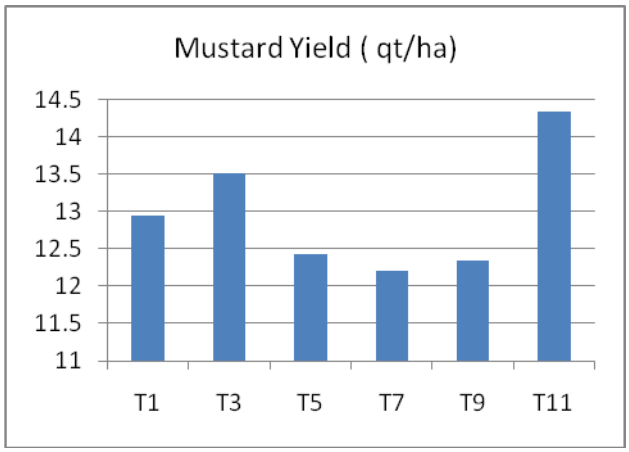

Fig. 3 Mustard yield (qt/ha)

Table 2 Mustard yield (qt/ha)

Treatments	Mustard Yield (qt/ha)
T1	12.94
T3	13.51
T5	12.42
T7	12.21
T9	12.34
T11	11.33
SE(m)	0.17
CD (5%)	0.54
CD (1%)	0.77

It could be concluded that intercrops have not imposed any competition neither on the growth and development of aonla nor the productivity of intercrops were affected by Aonla [19]. Higher grain yield of intercrops grown in combination with aonla in comparison to sole crops may be due to minimal competition between trees - crops for nutrient, moisture and light as aonla is a deep-rooted tree species and is able to draw nutrient and moisture from the deeper profiles of the soil. It may also be ascribed to microclimate moderation [26]. Socio-economic inputs as well as natural resources are efficiently utilized. Crop productivity under tree canopy is improved due to better soil fertility [27] and lesser effect of shade by reducing under-storey temperature and evapo-transpiration [28].

IV. CONCLUSION

The Aonla based agri-horticulture system may be a most beneficial agroforestry system in poor and marginal lands in the region. It may help farmers to earn income even in conditions of crop failure due to weather conditions. The Aonla based agri-horti system has been popularized through various farmer training programmes. This system is one of the good alternative of agriculture land use and economic returns for tree growers. However, better availability of market and storage facility may further improve the livelihood of practitioners of this system.

ACKNOWLEDGEMENT

The authors are grateful to FRCER, Prayagraj for supporting this work and Council of Science and Technology, Uttar Pradesh, Lucknow for supporting financial grant to the project under which the research activities were carried out.

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