ASSESSMENT OF SUGARCANE INTER CROPPING WITH DIFFERENT CROPS

Kanza Khan*, Muhammad Ehsan Khan*
*University of Agriculture, Faisalabad.
**Sugarcane Research and Development Board
Corresponding Author email: kanzakhan3346@gmail.com

ABSTRACT

The rapidly growing population of Pakistan needs to fulfill its food and nutrition requirements, and to achieve this, a collaborative strategy must be adopted to increase productivity by intensifying land use. Intercropping, which involves cultivating multiple crops in the same space simultaneously, is an advanced management practice that improves soil fertility and increases yield on a given piece of land by utilizing a mixture of crops with different abilities in rooting, canopy structures, height, and nutrient requirements. Intercropping is particularly beneficial for smallholder farmers in the sub-tropics, where intercropping sugarcane and legumes is widespread due to the legume's ability to address declining soil fertility. This review paper focuses on the role of intercropping systems in improving the growth, yield, and nutrient status of sugarcane in smallholder farms in semi-arid areas of Pakistan and other countries. The study discusses the different intercropping systems used in sugarcane and their effectiveness in increasing productivity, profitability, water use efficiency, and controlling weeds, pests, and diseases. The findings of this study will be useful for researchers involved in this field.

INTRODUCTION

Sugarcane, which belongs to the Saccharum spp. hybrid complex, is a significant cash crop in Pakistan and is widely grown in tropical and subtropical regions of the world. The sugar industry is the second-largest agro-industry in Pakistan, providing a source of food, fuel, fodder, and fiber, and plays a crucial role in the national economy. Globally, sugarcane is the main sugar-producing crop and contributes nearly 75% to the total sugar pool. In Pakistan, sugarcane covers an area of 1.260 million hectares, with a production of 88.65 million tonnes and a yield of 70.34 kg/ha. In Punjab, it covers 7.76 lakh hectares, with a production of 577 lakhtonnes and a productivity of 73.36 tonnes/ha (PSMA, 2021). Intercropping was initially practiced as insurance against crop failure under rain-fed conditions. Nowadays, intercropping is mainly used to increase productivity per unit area and provide stability in production. The intercropping system efficiently utilizes resources and increases productivity. The primary advantage of intercropping is achieving greater yield on a given piece of land by making more efficient use of growth resources through the use of a mixture of crops with different rooting abilities, canopy structures, height, and nutrient requirements based on the complementary utilization of growth resources by the component crops. Legumes, when used as an intercrop, increase soil conservation through greater ground cover than sole cropping and improve soil fertility through biological nitrogen fixation compared to monoculture. Sugarcane has a slow growth rate at the initial stage with low leaf canopy, providing sufficient uncovered area for some crops to be grown. As a long-duration and widely spaced crop, sugarcane offers good possibilities for growing early-maturing intercrops to harness the potentiality of the environment and use natural resources to increase production and net profit per unit area per unit of time. These features offer a potential scope to intercrop relatively short-duration and quick-growing crops to exploit land resources more efficiently.

Literature Review

Literature reviews on various aspects of intercropping in sugarcane, including growth, yield, economics, quality, soil nutrient status, as well as physical, chemical, and biological properties of soil, were collected in January, 2021 through internet searches using Google's search engines worldwide. The review encompassed published and unpublished sources such as reports, research papers, and theses from the past 25 years.

RESULT AND DISCUSSION

Growth, yield and economics of intercropping

The most profitable intercropping combination for sugarcane is cane and garlic. Garlic does not compete much with sugarcane for light and shade, and a companion crop of these two plants resulted in a cane yield of 111.47 tha^{-1} and 4.18 tonnes of garlic, with only a slight decline of 5.3% in cane yield compared to the sole crop of sugarcane in Pakistan (Bukhtiar and Muhammad in 1988). Ali et al. in 1987 and Ahmed et al. in 1991 made similar observations.

Garlic should be sown in between the rows of sugarcane at a spacing of 90 cm. To maintain proper spacing, three rows of garlic should be planted at a distance of 15 cm, with a plant-to-plant distance of 10 cm. If the cane row spaces are 120 cm wide, garlic can be planted in four rows (Ali et al. in 1987 and Ahmed et al. in 1991). According to Patel et al., (1984), intercropping sugarcane with garlic resulted in significantly higher yields of cane, single cane weight, and commercial cane sugar. Meanwhile, sugarcane intercropped with onion had higher intercrop yield and net return. In order to cultivate a profitable combination of cane and maize, it is essential to plant both crops early in the season, preferably during the first two weeks of February. This allows the maize to grow and mature rapidly before the tillering phase of the cane. For cane, inter-row spaces of 90 to 120 cm should be used for planting, and the inter-row spaces of the cane should be cultivated as a seed bed for maize when irrigated. The maize seeds should be drilled in a single row if the cane row space is 90 cm and in two rows if the space is 120 cm, with a plant-to-plant distance of 15 cm. If trench planting is used, maize seeds should be dibbled on both sides of the trenches. To avoid the exhaustive effect of this intercrop combination, the cane field should be enriched with a significant amount of farm yard manure. Dual row planting of cane can accommodate exhaustive crops and produce profitable yields of both cane and maize (Balde, 2011)Rana et al. (2006) observed that sugarcane + maize intercropping produced significantly higher millable cane and cane yield, with cane equivalent yield being the highest under this treatment, along with maximum net return and B:C ratio. However, sugarcane + mash gave equally high yield.

Varghese et al. (2006) revealed that sugarcane intercropped with vegetable peas produced significantly higher cane yield, land equivalent ratio (LER), and B:C ratio, with higher cane weight.Peas are a legume vegetable that provides a profitable return and can be used for good biomass incorporation into soil. Additionally, all leafy vegetables have high biomass that is beneficial for soil incorporation. To achieve successful intercropping of vegetables, wider rows are recommended, but paired row planting is preferable for managing profitable intercropping. It is important to note that intercropping should aim to supplement cash returns without compromising cane yield.

Singh et al. (2010) found that single-bud vertical planted sugarcane + garlic had significantly higher cane yield and cane equivalent yield, followed by sugarcane + radish vegetable, with net return and B: C ratio being higher in the former treatment. Numerous studies have investigated the impact of cane and wheat intercropping systems on crop yield, with results showing that wheat has a negative effect on cane yield. For example, one study found that while a sole cane crop produced 133.97 tons per hectare, a combination of cane and wheat yielded 118.04 tons of cane and 3.385 tons of wheat per hectare, resulting in a 11.9% reduction in cane yield

(Bukhtiar and Muhammad, 1988).Suryawanshi et al. (2010) reported that sugarcane + wheat intercropping gave higher net monetary return (NMR) and B: C ratio.

According to Islam and Islam (2016), the cane + potato combination is the most profitable intercropping system, provided that planting time, fertilizer needs, weed control, and earthing up operations are carefully managed. In particular, September-planted potato on ridges followed by cane in furrows produced higher yields than potato alone in September followed by cane in March. Furthermore, the highest cane yield was achieved with a September cane planting at 90 cm (101.16 t ha^{-1}) with potato (10.45 t ha^{-1}), followed closely by cane at 120 cm with potato (Malik and Kamoka, 1992). Kumar et al. (2011) noticed that sole sugarcane and sugarcane + potato intercropping had similar cane yield, while sugarcane + onion intercropping produced higher cane equivalent yield and net returns. Studies by Nayyar et al. (1987) and Ahmed et al. (1988) have shown that intercropping okra and sugarcane is a highly profitable combination, with an EMV of more than one. Although there was a reported reduction in cane yield of 6 to 17%, the monetary return from the okra crop compensated for this yield decline (Table-13). To minimize the shading effect of the intercrop, cane was planted in dual row strips with row spacing of 45-135-45 cm. Paired row planting with a spacing of 30-150-30 cm was found to be more financially beneficial than the 45-135-45 cm row spacing. Therefore, wider inter row spaces are recommended to reduce light and shade competition, and two adjacent cane rows at 30/45 cm can make up the required plant population for cane. Keshavaiah et al. (2014) reported that sugarcane + french bean gave similar yields to pure sugarcane crop, while sugarcane + bhendi had significantly higher cane equivalent yield, with sugarcane + vegetable soybean having higher total income and B: C ratio.

Khippal et al. (2016) showed that sugarcane + pea intercropping had similar cane yield to sole sugarcane crop, with net return being higher in the former treatment. Rana et al. (2006) found that sugarcane + mash resulted in significantly higher juice sucrose levels, which were comparable to those of sole sugarcane, sugarcane + mustard, and sugarcane + maize. They also observed that this treatment produced the highest CCS.

Inter-cropping with lentil crops can yield a reasonably good profit margin without affecting the productivity of cane. Lentil has minimal competition for light and nutrients, and does not shade cane, and can even improve cane yield through symbiotic nitrogen fixation (Akhter et al., 2001). In fact, an EMV of 1.33 and 1.20 was obtained from intercropping cane with lentil (Table-4). Furthermore, it has been observed that lentil intercropped in ratoon can improve cane yield compared to a sole crop (Singh et al., 2008).Singh et al. (2008) revealed that the highest amounts of available nitrogen and soil infiltration rates were obtained from the sugarcane + lentil intercropping system in both plant and ratoon sugarcane, with the lowest bulk density also observed in this treatment. Singh et al. (2011) found significantly higher commercial cane sugar levels in sole sugarcane, which were comparable to sugarcane + LP (1:3), with significantly higher purity percentages observed in sugarcane + LP (1:4), but comparable to all other treatments except sugarcane + LG (B). Brix readings were also higher in the same treatment.

Patel and Patel (2012) observed significantly higher values of available nitrogen and available phosphorus in the soil after sugarcane harvest with the application of a 100% recommended dose of phosphorus with green gram intercrop treatment, while available K2O and S were found to be non-significant. Keshavaiah et al. (2014) reported significantly higher reducing sugar and ash levels in the sugar cane + French bean intercropping system, while sucrose levels were not significantly affected by various treatments.

CONCLUSION

Growing a variety of crops such as sunnhemp, maize, radish, linseed, pea, cucumber, wheat, soybean, onion, amaranth, green gram, and french bean alongside sugarcane can increase sugarcane yield while also providing better economic returns. In addition, this intercropping system can enhance soil quality by improving nutrient status and physical and chemical properties of the soil, resulting in better quality crops.

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