



MAXIMISING YIELD AND PROFIT THROUGH DIVERSIFICATION IN SUGARCANE: A FARMER'S PERSPECTIVE

Karanjeet Singh Dhaliwal*

Cane Development & Extension Services, Rana Sugars Unit Bilari, Balwada and Sahbad

Abstract

Field experiment were conducted in two consecutive years (2017 and 2018) in order to explore the effects of intercropping sugarcane with potato, onion in autumn and chilly in spring. This crisis demands alternate strategy to increase agricultural productivity and maximum economic returns per acre to feed the gigantic population. Intercropping in sugarcane has received much attention due to long duration and time to grow short duration crops and becoming popular among farmers, if it is properly managed. Intercropping has the potential to encourage the farmers to get maximum economic return per acre per annum. In the present study, an attempt was made to intercrop potato and onion, in autumn sowing and chilly in spring sown sugarcane plant. An experiment was made to evaluate the agronomic and economic performance of different intercrops with sugarcane in trench sowing system with distance of 13 cm row to row. Maximum return was achieved with sugarcane + potato as intercrop followed by onion and chilly in the study. Maximum number of tiller, millable cane and cane diameter and unit stalk weight were observed in the same crop combination. Brix (%) of cane juice did not varied significantly in different intercropping system studied. Hence, it is recommended to use these intercrop to increase the economic returns of sugarcane farmers in India.

Key words: Sugarcane, intercropping economic benefits, yield and intercrop of sugarbeet.

Introduction

India is the second largest producer of sugar after Brazil. Over five million farmers are involved in the cultivation of sugarcane in tropical and subtropical India. The two distinct agro-climatic regions of the crop in the country: subtropical region shares about 45% and 55% of the total sugarcane area and production in country (Sundara, 2011). Intercropping refers to growing two or more crops simultaneously on the same piece of land with a definite row-planting pattern to obtain higher productivity per unit area. Rapidly increasing population, increased demand for food, limited scope for extension of cultivation to new areas, diversified needs of small farmers for food and cash etc. have necessitated the adoption of intercropping systems. In the case of sugarcane, much of the space between two rows of sugarcane remains unutilized for an initial period of 90-120 days, due to slow crop growth. Companion cropping offers an opportunity for profitable utilization of available space. Sugarcane growers take advantage of this and grow various short duration crops like cereals, pulses, vegetables and spices as intercrops to obtain interim return. Small sugarcane growers need not wait until the harvest of the sole crop to obtain financial returns. Intercropping of economically important short duration crops with sugarcane through utilization of the present limited land resources would help to sustain sugarcane cultivation and provide interim return to marginal and small farmers, besides meeting the ever-increasing demand for vegetables and pulses.

Potato has been reported to be promising intercropping autumn planted sugarcane in subtropical India. The results of

the experiments carried out on the effect of intercropping of potato in sugarcane were reviewed by Rathi and Singh (1979). There have been several studies on intercropping of potato in sugarcane in Uttar Pradesh (Yadav and Prasad, 1991), Madhya Pradesh (Sharma and Dubey, 1994) and north Karnataka (Roodagi *et al.*, 2000). Onion as a spice and vegetable was evaluated as intercrop by Kirtikar *et al.* (1972), Mathur (1980) and Singh and Rani (1996). The yield of onion could be increased under paired row system of cane plantation by accommodating higher intercrop population compared to the single row system. Intercropping onion with paired row cane showed the highest potential for increasing the net returns per unit area (US\$ 562/ha) under intercropped systems (Imam *et al.*, 1990). Higher yield of cane due to intercropping with onion was reported (Parashar *et al.*, 1979). Onion was found to be a remunerative intercrop in studies at Sehore, Madhya Pradesh (Sharma and Dubey, 1994; Sharma *et al.*, 1986).

Great potential exists in India for increasing crop production and productivity through wider use of multiple cropping. In long duration crops like sugarcane, intercropping holds much promise. Due to slow establishment of sugarcane during the first 90-120 days, the greatest scope for complementary effect lies in the addition of annual intercrops to the temporal system to improve resource use efficiency in the early crop growth period (Gopalsundaram and Kailasam, 2003).

Legume intercrops in cropping systems enhance soil fertility through the excretion of amino acids into the rhizosphere. The nitrogen fixed by the legume intercrop may

*Corresponding author Email: kjsdhaliwal@yahoo.com

be available to the associated sugarcane in the current season itself, as sugarcane remains in the field for over nine months after the harvest of the legumes (Kailasam, 1994). A further possibility of soil fertility improvement is through addition of crop residues, which on decomposition adds to the fertility of the soil. Since considerable addition of nutrient occurs through intercrop, there is a possibility of reducing N application through fertilizer. In general the optimum row spacing recommended for sugarcane is 90 cm which is widely followed in tropical India. Reduced row spacing is often preferred to accommodate higher cane population and increase cane yield in short duration and early maturing varieties (Sundara, 1994). With the introduction of very high tillering and high yielding varieties of sugarcane, there is a possibility to adopt wider row spacing and still sustain cane productivity. Such wide row spacing permits intercropping without adversely affecting the cane yield and thus increases the overall productivity and profitability of the system. The present problem of labour shortage may worsen in future affecting the survival of sugar industry and cane growers. Wide row spacing becomes an important agronomic consideration in future in developing countries (For example, 150 cm row spacing was successfully attempted in the cane area of Uttar Pradesh state, India, which recorded higher yield than 90 cm row spacing (Nagendran and Palanisamy, 1997).

High tillering and low tiller mortality in wide row spacing helped achieve such high yields in spite of the lower seed rate used. Wide row spacing of 150 cm is preferable for sugarcane based intercropping systems. In the subtropical region, sugarcane is normally planted in autumn (September-October), *i.e.* before the onset of winter or during the spring season (February-April), *i.e.* after the cessation of winter. The cane planted in the autumn season germinates before the onset of winter and remains in the field without much growth until the spring sets in. During this period, the cane does not make much demand for the growth resources. This facilitates rising of any Rabi crop as intercrop with autumn planted sugarcane. Several studies demonstrated that the total productivity of crops in sugarcane + rabi crop intercropping system is substantially higher than the total productivity of crop in winter followed by sole sugarcane planted in spring season. Keeping in view of additional advantage and income of intercropping, three different crops potato, onion and chilli were attempted in present study to see the performance of sugarcane and intercrop for better yields and better economic returns.

Materials and Methods

The experiment was conducted in Javandhia Group sugar industry research station field in 2018-2019 cropping season. The experiment comprised of three treatments *viz.*, T₁: solo sugarcane trench (control), T₂: Sugarcane + potato followed by second intercrop sesame and T₃: sugarcane + onion T₄: sugarcane + chilly. 2 plot size was 43560 square feet each. sugarcane variety Co0238, Co 86032 variety were used as test crop in the experiment. Row to row and plant to plant distance were 152.5cm and 45.72 cm, respectively with single bud sowing system. The spaces between two rows of sugarcane were 152.5 cm. Inter crops *viz.* onion and potatoes were planted between the vacant spaces of paired row sugarcane.

Onion bulbs were planted in two rows with 20 cm row to row and 10 cm plant to plant spacing. Potato tubers were planted in one rows following the spacing row to row 152.5 cm and plant to plant 10 cm, chilly was planted one row to row 152.5 cm plant to plant 60.96 cm. Fertilizer were applied @ N-130, P-35, K-60, S-20, Zn-3, N-50, P-20, K-30 and S-10, N-48.6, P-17.4, K-21, S-12.6 and Zn-2.4 Kg ha⁻¹ for cane; potato; onion and chilly, respectively. Mustard oil cake @ 1 t ha⁻¹ and cow dung 7 t ha⁻¹ as organic manure (OM) were applied for potato and cow dung @ 3 t ha⁻¹ were applied for onion. In sugarcane, full dose of P, S and Zn were applied in the trenches and thoroughly mixed with the soil by spade just prior to planting. Half of N and K were applied at 30 days after transplanting (DAT), remaining N and K were applied at 150 DAT. In potato, full dose of P, K and half of N were applied in the bottom of the furrow and was covered with 5 cm soil before planting. The rest amount of N was applied at the side of the row and covered with soil at 45 days after planting. In onion, full doses of P, K, S, one-third of N were applied at the time of land preparation; half of remaining N were applied at 21 and rest amount of N at 42 days after plantation. In chilly, full dose of P, K, S and Zn, half of N were applied at the time of final land preparation and rest amount of N were applied after 30 days of sowing. All cultural and pest control measures were done when required. Data on yield and yield attributing parameters of cane and Brix (%) of sugarcane and yield of intercrops were recorded and analyzed statistically at 5% level of probability using LSD test. Cost of production was calculated on the basis of the cost of land preparation, seed cost, fertilizer cost, pesticide cost, labour cost and interest on current capital. The crop should put forth its biomass early and cover the land surface so that weed growth is minimised and essentially it should come to harvest within 75-80 days of sugarcane planting. Most important is that at which time which crop is favourable for intercrop. The different treatments were-

1. T1 solo sugarcane
2. T2 Sugarcane + Potato second week October autumn sowing
3. T3 Sugarcane + Onion second week of October autumn sowing
4. T4 Sugarcane + Chilly February spring sowing

Solo Sugarcane

Treatments comprised of three cropping systems *viz.*, solo sugarcane, sugarcane + potato, sugarcane + onion and were tested in randomized block design with three replications. Autumn cane was planted in second week of October. Two rows of onion and one row of potato were sown in between two rows of sugarcane on second week of October. Sugarcane was fertilized with 200:80:80 kg of NPK. Whereas, intercrops were fertilized on the basis of their population ratio in sole and intercropping situations with RDF. Other operations were done as per recommended package of practices for the respective intercrops. Sugarcane was given with full phosphorus and potassium and half nitrogen as basal and remaining half nitrogen top dressed in four three splits after harvest of intercrop.

Intercrop of Sugarcane + Potato

Intercrop of potato + sugarcane is quite profitable, if we plant sugarcane with a distance of 152.5cm row to row it's easy to take one row of potato as intercrop both crops dose not disturbed each other in yield. Both the corporate sector and small growers are involved in potato production, the former accounting for about 52% of production. About 42% of the potato is produced by small growers who do not have land and who rent interrows of sugar cane from sugar estates.

Potato is planted in every interrow of plant cane and in alternate interrows of ratoon cane, and is harvested before the cane canopy closes. The potato does not reduce cane yields, nor does cane reduce potato yields. A package of husbandry practices has been developed and has been widely and rapidly adopted. The system is easy to manage and most cultural practices can be, mechanized. Harvesting of potato take place after 80 days of sowing. After harvesting of potato all sugarcane operations are easy to be done.

Intercrop of Sugarcane + Onion

Onion as a spice and vegetable was evaluated as intercrop with cane row of 152.5 cm row to row. The yield of onion could be increased under paired row system of cane plantation by accommodating higher intercrop population compared to the single row system. The yield of onion under paired row systems was 4.4 t/h while it was 2.25 t/ha under single row system. Intercropping onion with paired row cane showed the highest potential for increasing the net returns per unit area. Compared to other crops, onion exerted least detrimental effect on the emergence, tiller, millable cane and yield of sugarcane.

Intercrop of Sugarcane + Chilly

Chilly is known as the most valuable crop of India. It is used as a principle ingredient of various curries and chutneys, also used in vegetables, spices, condiments, sauces and pickles. Sugarcane practice with intercrop chilly was been practiced in spring season and got great results as chilly crop is harvested in 110-120 days. Intercrop of chilly + sugarcane is quite profitable. If we plant sugarcane with a distance of 150cm row to row its easy to take one row of chilly as intercrop both crops dose not disturbed each other in yield. Both the corporate sector and small growers are involved in chilly production, the former accounting for about 38% of production. About 20% of the chilly is produced by small growers who do not have land and who rent interrows of sugar cane from sugar estates.

Sugarcane yield increase by 17-24 t/ha, whereas farmer earned additional profit ranging between 103000 to 233000 (Table 1).

Expanded trial programme

After the initial trials had indicated that there were indeed potential benefits to be gained from intercropping cane with food crops, the trial programme was expanded considerably to investigate these benefits under a number of different climatic conditions. Specific trial sites were chosen in areas where large numbers of small scale growers were based. A small experimental trial under ICAR-IISR, Lucknow guidelines was been followed results are yet to come

Sugarcane with sugarbeet in with Dr. A.K. Sah from IISR and field observation by Dr. A.K. Sah.

Results and Discussion

The economics of different intercrops with sugarcane were worked out and are presented in the data revealed. Higher yield of cane due to intercropping with potato was reported. Therefore, cultivation of short duration spices and vegetables like onion, garlic and coriander as intercrops in sugarcane can be a successful package as it provides the needed income during the early stages and increases the total productivity without affecting the cane yield in the system proved to be best combination, found similar results with sugarcane + onion.

Potato has been reported to be promising intercropping autumn planted sugarcane in subtropical India with row spacing of 152.5 cm row to row in sugarcane crop. The results of the experiments carried out on the effect of intercropping of potato in sugarcane were reviewed by Rathi and Singh (1979). There have been several studies on intercropping of potato in sugarcane in Uttar Pradesh (Yadav and Prasad, 1991; Karanjeet Singh Dhaliwal, 2016); Punjab (Kanwar *et al.*, 1990); Maharashtra (Nankar, 1990; Solanke *et al.*, 1990), Madhya Pradesh (Sharma and Dubey, 1994). Sugarcane + potato and many other crop combination. Maximum income increased 38% in Madhya Pradesh and Uttar Pradesh, respectively under sugarcane + onion intercropping system and the second highest income was 26.73% under sugarcane + potato intercropping revealed that the highest adjusted cane yield of 96.20 t ha⁻¹ at observation. From the above discussion it is inferred that cultivation of short duration intercrops like onion and potato followed by sesame with sugarcane in paired row system were found profitable over sole planted sugarcane. Hence, both crop combinations may be suggested for achieving higher cane yield as well as to get interim benefit from a same piece of land.

Conclusion

The review clearly brings out the positive effects of combining crops in sugarcane based cropping systems. Though there are overall biological advantages in intercropping system, most of the studies have indicated depressing effect of intercrops on the base crop of sugarcane. Although intercropping has been practiced traditionally for thousands of years and is widespread in many parts of the world, it is still poorly understood from an agronomic perspective and research in this area is far less advanced than comparable work in monoculture. This is due in part to the wide use of pure crop cultures in the developed world, in part to the relative lack of resources in the developing world, but not least to the complexity of the problems involved. Thus, more research is needed to better understand how intercrops function and to develop intercropping systems that are compatible with current farming systems. For an intercrop combination to be biologically advantageous, agro-techniques such as fertilizer application, seed rate of intercrop and base crop and selection of suitable genotypes must be taken care of to reduce the depressing effect of intercrops on sugarcane and to increase the productivity and profitability of the intercropping system.

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Table 1: Economic analysis of intercropping with sugarcane variety co 0238 and co 86032

Cropping system	Yield (t ha ⁻¹)		Return (Rs/ha)		Net profit (Rs/ha)
	Cane	Intercrop	Cane	Intercrop	
T1) Solo sugarcane	77	-	242550	-	177560
T2) Sugarcane + Potato	85	29.0	267750	232000	350500
T3) Sugarcane + Onion	83	1.60	261450	60800	226500
T4) Sugarcane + Chilly	84	1.5	264600	72000	220600