AGRONOMIC MANAGEMENT OF INTERCROPPING IN SUGARCANE AND ITS ECONOMIC IMPLICATIONS

By

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KEYWORDS: Number of Millable Canes, Stalk Population, Cane Yield, Intercrops, Economics.

Abstract

GROWTH rate of sugarcane during the initial stages is rather slow with the low canopy coverage, and it is possible to exploit the potential of the cropping system by adjusting crop geometry and utilisation of inter-crops. Therefore, a field experiment was conducted to assess the economic benefits of intercrops with different planting configurations in sugarcane. Dual-row (60–120–60 cm) and single-row (90 cm) methods of planting were deployed as main plots and intercrops comprising sunnhemp, maize, cowpea (green manure), soybean (inter-crop), peanut, potato and french bean were treated as subplots. Planting systems did not alter significantly the number of millable canes (NMC) or cane yield. However, sunnhemp, cowpea grown and soybean recorded higher NMC (92 080, 89 830 and 87 830/ha respectively) than cane alone (85 910/ha), while maize intercropping gave 68 880 NMC and the sugarcane yields were 111.1, 109.1, 106.9 and 70.8 t/ha, respectively for the 4 inter-crops and 107.4 t/ha for cane alone. Higher cane yields are attributed to the optimum shoot population which later on converted higher NMC and cane weight due to *in situ* incorporation of green manure and its further decomposition in building organic matter content of soil. Detrimental effect on NMC and cane yield was noticed due to intercropping of maize in sugarcane. Compared to the normal single row configuration, dual-row planting with the same cost of cultivation improved B:C ratio from 2.17 to 2:76, due to higher cane yields. As a result of the grain yield of soybean (1.5 t/ha) and lower cost of production in soybean inter-cropping, this strategy recorded the highest net return (Rs68, 336/ha) with B:C ratio of 3.21 compared to other inter-crops. Conversely, although maize and potato yields were higher, these treatments produced lower net income and B: C ratios due to the reduction in cane yield. Post-cane harvest data indicate that inter-cropping has a positive effect on the chemical properties of soil.

Introduction

Sugarcane is one of the more important commercial crops of India and is cultivated with row spacing of 75–90 cm. The growth rate of sugarcane during its initial stages (90–100 days) is rather slow, with the leaf canopy providing sufficient uncovered area for growing of other crops. Inter-cropping in sugarcane with short duration crops is agronomically advantageous and could provide additional revenue (Ayyer, 1963). Further, alterations in planting methods that do not compromise cane yields will provide additional opportunity to exploit the potential of the crop by growing intercrops.

Sugarcane, as a long duration crop, gives income about a year after planting, and there is a dire need to diversify the cropping system to provide shorter-term income by introducing other crops, either as sequential or inter-cropping strategies, especially for farmers having smaller land holdings. Jamuna *et al*. (2007) indicated that the cane yields were not affected by dual-row planting,

and cane yields were higher with the dual-row system than for wider rows. Devaraj and Shanmugsundaram (1987) observed that cane yield was improved by adopting dual rows of 40–80 cm spacing compared with conventional 80 cm row planting and that the dual-row system allowed growth of intercrops. Therefore, a study was initiated to study the effect of growth and yield attributes, yield of cane and sugar, economics and chemical properties of soil when sugarcane was grown in different row configurations and with or without intercrops.

Material and methods

A field experiment was conducted at the K.J. Somaiya's Karnataka Institute of Applied Agricultural Research, in India during 1997–98. The vertisol soil had available nitrogen, phosphorus and potassium values of 285, 7.3 and 0.419 kg/ha, mg/kg and cmol/kg respectively and a soil pH of 8.1. The field investigation consisted of two planting methods *viz.*, ridge and furrow planting (90 cm) and dual rows of 60–120–60 cm as main treatments and seven intercrops *viz.*, sunnhemp (green manure), maize, cowpea (green manure), soybean, peanut, potato, french bean and sole sugarcane as subplots in a split plot design replicated four times. An early maturing CoC671 cultivar of sugarcane was used for experimentation. Intercrops *viz.* sunnhemp, maize, cowpea, soybean, peanut, potato and french bean were sown simultaneously at the time of sugarcane planting. Sunnhemp, cowpea, soybean, peanut, maize and potato were sown in a row proportion of 1:1 in single rows of cane. In the case of dual rows, sunnhemp, cowpea, soybean, peanut and french bean were sown in row proportion of 2:3, while maize and potato were sown in a row proportion of 2:2. Sunnhemp and cowpea were incorporated at 45 days after planting of sugarcane. Yields of different intercrops were recorded at harvest. Sugarcane growth, yield attributes, yield and juice quality parameters were recorded .Soil was analysed as per the standard procedure after harvesting of sugarcane. Gross income, cultivation cost, net return and B:C ratios were calculated for the different systems. Statistical analysis was done by using Duncan Multiple range Test (DMRT) and data were presented in a homogeneous group.

Results and discussion

Experimental results reveal that different planting configurations had no significant impact (p=0.05) on growth and cane yield attributes *viz.*, single cane weight, girth of cane, length of internodes, number of internodes, plant height, NMC, and cane and sugar yields. Of the inter-cropping systems, sunnhemp, cowpea, soybean, potato, french bean and sugarcane alone treatments gave superior single stalk weight compared to the maize intercropping system (Table 1).

Table 1—Effect of planting methods and intercropping on growth, yield attributes and yield of cane and sugar.

Treatment	Single cane weight (kg)	Girth of cane (cm)	Length of internode (cm)	No. of internode (cm)	Plant height	NMC ('000/ ha.)	Cane yield (t/ha)	Sugar yield (t/ha)
Planting methods								
P1. Normal method	1.2 a	2.9 a	10.42a	21.2 a	170.9 a	84.7 a	101.2 a	11.2 a
P2. Paired row	1.2 a	2.9 a	10.53a	21.6 a	178.1 a	85.7 a	102.6 a	11.3 a
LSD(p=0.05)	NS	NS	NS	NS	NS	NS	NS	NS
Intercropping systems								
T1 Cane + sunnhemp	1.3 a	3.0 a	11.1 a	22.3 a	182.1 a	92.08 a	111.1 a	12.5 a
T2 Cane + maize	1.0 b	2.9 a	9.3 c	19.2 a	161.4 a	68.88 c	70.8 b	7.6 b
T3 Cane + cowpea	1.3 a	3.0 a	10.9 ab	22.6 a	180.1 a	89.83 ab	109.1 a	12.3 a
T4 Cane + soybean	1.2 a	2.9 a	10.6 ab	22.1 a	177.4 a	87.83 ab	106.9 a	12.1 a
T5 Cane + peanut	1.2 a	2.90 a	10.2 b	20.5 a	170.1 a	83.70 b	100.7 a	10.9 a
T6 Cane + potato	1.2 a	2.8 a	10.4 ab	20.6 a	169.3 a	85.53 b	103.9 a	11.5 a
T7 Cane + French bean	1.2 a	2.9 a	10.6 ab	21.3 a	177.0 a	87.57 ab	105.5 a	11.8 a
T8 Cane alone	1.3 a	2.9 a	10.8 ab	22.3 a	178.7 a	86.02 b	107.4 a	11.6 a
LSD(p=0.05)	0.15	NS	0.76	NS	NS	5.49	12.37	1.88

Numbers in each column followed by the same letter are not significantly different at p = 0.05
DAP = Days after planting

However, cane girth, number of internodes and plant height were unaltered in the different inter-cropping systems. However, sunnhemp and cowpea significantly enhanced cane height and number of internodes over other systems.

Similarly the NMC and cane yield were significantly higher (p=0.05) in sunnhemp, cowpea and soybean inter-cropping systems and the cane alone control compared to maize inter-cropping (Table 1). Higher cane yield was obtained due to the optimum shoot population which eventually helped in producing NMC values and *in situ* incorporation of green manure. Incorporation of green manure and its further decomposition in building organic matter of soil and uptake of nutrients which led to higher cane weight, accomplished with better cane girth and internodal length as observed in the findings of Kathiresan and Ayyamperumal (1996).

Yield of the sugar alone system was similar to that of cane yield in the different inter-cropping systems, with the exception of the cane-maize system (Table 1). Intercropping of peanut, potato and french bean in sugarcane had no impact on growth parameters and yield of sugarcane, and these results are consistent with the opinion expressed by Srinivas (1996). Sugarcane yield reduction from 107.39 t/ha in the cane alone system to 70.82 t/ha with maize inter-cropping indicates that maize adversely affected the various growth and yield parameters of sugarcane.

Economics

The net returns were higher in dual row planting (Rs58 534/ha) compared to single rows (Rs56 628 /ha) due to increased yields for the same cost of production (Table 2). Similarly, the B:C ratio in dual rows was higher by 0.29 compared to the single-row method of planting. Among the intercropping systems, sugarcane plus soybean gave highest gross income (Rs99 248/ha), net income (Rs68 336/ha) and B:C ratio (3.21) compared to other all treatments.

The highest net income in sugarcane inter-cropped with soybean was mainly due to higher cane yield (111.09 t/ha) coupled with soybean grain yield of soybean 1.5 t/ha. Similar findings were reported by Biradar *et al.* (1995). Although maize yield were higher compared to other inter-crops, the net income was the least due to drastic reduction in cane yields.

Table 2—Economics of planting methods and intercropping systems in sugarcane.

Treatment	Intercrops yield t/ha	Gross income (Rs.)	Cost of cultivation (Rs.ha)			Net return (Rs./ha)	B.C.
			Cane	Intercrops	Total		
Planting methods							
P1. Normal method	3.6	89 836	27 710	5498	33 208	56 628	2.17
P2. Paired row	4.2	91 743	27 710	5498	33 208	58 635	2.76
Intercropping systems							
T1 Cane + sunnhemp	7.5	89 924	27 710	2080	29 790	60 134	3.02
T2 Cane + maize	2.9	68 142	27 710	4058	31 768	36 374	2.15
T3 Cane + cowpea	6.0	88 221	27 710	1910	29 620	58 601	2.96
T4 Cane + soybean	1.5	99 248	27 710	3202	30 912	68 336	3.21
T5 Cane + peanut	0.9	90 014	27 710	4569	32 299	57 715	2.79
T6 Cane + Potato	6.8	110 319	27 710	23 103	50 813	59 506	2.17
T7Cane+French bean	0.8	94 540	27 710	5049	32 759	61 781	2.89
T8 Cane alone	–	85 910	27 710	–	27 710	58 220	3.10

Chemical properties of soil

There was no significant difference observed in organic carbon content across planting methods or intercropping systems or their interactions (Table 3). Similar results were observed by Pandit and Sinha (1981) due to incorporation of cowpea. Available nitrogen, phosphorus, potash of the soil after harvest of sugarcane recorded non-significant results with respect to planting methods.

Among the inter-cropping systems, sunnhemp, cowpea, soybean, peanut, potato and french bean showed significantly (p = 0.05) higher residual available nitrogen, phosphorus and potassium compared to maize inter-cropping system. Shankaraiah and Nagaraju (1997) showed improved available nitrogen, phosphorus and potassium due to intercropping and incorporation of legumes.

Table 3—Chemical properties of soil as influenced by planting methods and inter-cropping in sugarcane.

Treatment	Available nitrogen (kg/ha)	Available phosphorus (kg/ha)	Available potassium (kg/ha)
Planting methods			
P1. Normal method	299.1 a	21.5 a	330.5 a
P2. Paired row	301.5 a	22.9 a	333.8 a
LSD(p=0.05)	NS	NS	NS
Intercropping systems			
T1 Cane + sunnhemp	325.5 a	29.9 a	337.5 a
T2 Cane + maize	272.4 b	13.6 b	324.2 b
T3 Cane + cowpea	318.1 a	28.0 a	336.4 a
T4 Cane + soybean	312.4 a	25. a	335.2 a
T5 Cane + peanut	300.1 a	23.4 a	334.2 a
T6 Cane + Potato	300.0 a	24.0 a	334.2 a
T7 Cane + French bean	309.3 a	24.9 a	335.2 a
T8 Cane alone	271.2 b	13.5 b	325.5 b
LSD(p=0.05)	26.14	8.21	3.82

Numbers in each column followed by the same letter are not significantly different at p=0.05

Conclusions

The dual-row system was preferred over single rows due to its higher cane and sugar yield. Additional advantages of obtaining inter-cropping yield can also be exploited. Growing of soybean in sugarcane inter-cropping and incorporation of *in situ* green manures like sunnhemp and cowpea recorded higher yield and also improved the soil chemical properties to help to sustain yield of sugarcane. Maize and potato are not ideal inter-crops in sugarcane

Acknowledgements

The author acknowledges Shri.Samir S. Somaiya, Executive Director, Somaiya Group, Mumbai for help in carrying out the project and the encouragements from Chairman of Karnataka Sugar Institute and Secretary, Commerce and Industries, Commissioner for Cane Development and Director of Sugar, Government of Karnataka and Director, Karnataka Sugar Institute, Belgaum.

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CONDUITE AGRONOMIQUE DE CULTURES INTERCALIRES EN CANNE A SUCRE ET SES IMPLICATIONS ECONOMIQUES

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Résumé

LA CROISSANCE de la canne à sucre pendant les premiers stades est plutôt lente avec un faible taux de couverture, et il est alors possible d'exploiter le potentiel du système cultural en adaptant sa géométrie pour des cultures intercalaires. Aussi, un essai en champ a-t-il été conduit pour évaluer les bénéfices économiques de cultures intercalaires avec diverses configurations de plantation en culture de canne à sucre. Des modes de plantation, rang jumelé (60–120–60 cm) et rang simple (90 cm) ont constitué les traitements principaux et des cultures intercalaires comme la crotalaire, le maïs, le niébé (engrais vert), le soja (culture intercalaire), l'arachide, la pomme de terre et le haricot vert, ont constitué les traitements secondaires. Alors que la crotalaire, le niébé et le soja ont produit plus de tiges usinables (NMC) (respectivement 92 080, 89 830 et 87 830/ha) que la canne seule (85 910/ha), la culture intercalaire de maïs a donné 68 880 NMC. Les rendements de canne ont été de 111.1, 109.1, 106.9 et 70.8 t/ha, respectivement pour les 4 cultures intercalaires, et de 107.4 t/ha pour la canne seule. Les rendements les plus élevés en canne sont attribués aux plus forts taux de tallage, donnant plus tard le plus de tiges usinables et les plus forts rendements en raison de l'incorporation de l'engrais vert et à sa décomposition ultérieure en matière organique organique du sol. Comparé au système en simple rang, le rang jumelé, avec le même coût de production a augmenté le ratio B:C (Bénéfice/Coût) de 2.17 à 2.76, en raison des plus forts rendements canne. En raison de la récolte en grain du soja (1.5 t/ha) et du plus bas coût de production de cette culture intercalaire, en comparaison avec les autres cultures intercalaires, cette itinéraire a enregistré le plus fort revenu (Rs68,336/ha) avec un B:C ratio de 3.21. Inversement, quoique le maïs et les pommes de terre aient eu des rendements plus élevés, ces cultures ont produit les revenus nets et ratios B:C les plus faibles en raison de la réduction des rendements canne. Les données après récolte indiquent que les cultures intercalaires ont eu un effet positif sur les propriétés chimiques du sol.

EL MANEJO AGRONOMICO DEL CULTIVO INTERCALADO EN CANA DE AZUCAR Y SUS IMPLICACIONES ECONOMICAS

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PALABRAS CLAVE: Numero de Tallos Molederos, Población de Tallos, Rendimiento de Cana, Cultivos Intercalados, Economía.

Resumen

EL INDICE de crecimiento de la caña de azúcar durante los primeros estadios es más bien lento, con poca cobertura del follaje y se puede aprovechar el potencial del sistema intercalado, ajustando la geometría del cultivo y la utilización de cultivos intercalados. De este modo, se condujo un experimento para evaluar los beneficios económicos de los cultivos intercalados con diversas configuraciones de siembra en caña de azúcar. Se establecieron parcelas grandes con método de siembra de surco doble (60–120–60 cm) y de surco simple (0.9 cm), y como parcela pequeña cultivos intercalados como cáñamo, maíz, caupí (abono verde), soya (cultivo intercalado), maní, papa y judías. Los sistemas de siembra no alteraron significativamente el número de tallos molederos (NMC) o el rendimiento de caña. Sin embargo, al cultivar cáñamo, caupí y soya se registró un aumento en NMC (92 080, 89 830 y 87 830/ha respectivamente) que al sembrar caña sola (85 910/ha), mientras el maíz intercalado produjo 68 880 NMC y los rendimientos de caña con los cuatro cultivos intercalados fueron 111.1, 109.1, 106.9 y 70.8 ton/ha, respectivamente y 107.4 t/ha para caña de azúcar sola. Los rendimientos más altos de caña se atribuyen a la población óptima de tallos que consecutivamente se convirtieron en un NMC más alto y mayor peso de caña, esto debido a la incorporación *in situ* de abono verde y su posterior descomposición en materia orgánica del suelo. Se observó un efecto detrimental en NMC y rendimiento de caña al intercalar maíz con caña de azúcar. Al comparar el surco simple con la siembra en surco doble, este ultimo mejoró la relación B:C de 2.17 a 2.76, por los mayores rendimientos de caña. Como resultado del rendimiento en granos de soya (1.5 ton/ha) y su menor costo de producción, la estrategia de intercalar soya reportó el mayor retorno (Rs68, 336/ha) con una relación B:C de 3.2, comparada con otros cultivos intercalados. Por otro lado, a pesar de que el maíz y la papa produjeron mayores rendimientos, estos tratamientos reportaron menor ingreso neto y menor relación B:C, debido a la reducción en rendimiento de caña. Los datos post cosecha indican que el cultivo intercalado tiene un efecto positivo sobre las propiedades químicas del suelo.