

Correlation Of Sustainable Agriculture And Intercropping Models In Sugarcane

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ABSTRACT

Background: A form of multiple cropping, Intercropping, in which two or more crops are grown together in proximity and produces higher productivity per unit area. It ensures resource use efficiency of land, labor and inputs resources available at Farm. Here focus will be given that crop duration and peak growth period of intercrop and main crop did not overlapped and coincide. Planting geometry of intercrops adjusted in such a way that will minimize the shade effect on main crop **Methodology:** A research experiment was conducted at Sugarcane Research Institute (SRI), Faisalabad. In this experiment, various types of planting geometry was studied to find out optimum planting layout of canola best fitted in traditional (2.5 ft.) and recommended (4.0 ft.) sowing techniques of sugarcane. The Randomized Complete Block Design was applied in experiment and replicated thrice.

Results: The data of the research experiment revealed that the highest cane count (110 thousand/ha), cane yield (103.30 t/ha) and sugar yield (12.96 t/ha) was obtained in T6-sugarcane apart 4ft rows +2 line of canola. highest sugarcane income of Rs. 464850/- was found in T6- Sugarcane apart 4ft rows +2 lines of canola which is followed by T7 having sugarcane income of Rs. 431100/- and T4- Sugarcane apart 4ft rows +broad cast of canola with income of Rs. 373500/-. The lowest income of Rs. 222750/- was obtained in T1- Sugarcane apart 2.5ft rows +broad cast of canola.

Conclusion: Two lines of canola intercropped in four feet apart dual row sown sugarcane (recommended planting practice) will be more feasible, ease to do, economical and profitable than traditional planting geometry and is more sustainable way in profitable agriculture.

Keywords: Canola, Intercropping, economical, two lines, technique, planting.

Introduction

In agriculture, the potential of multiple cropping exist in wider row space to increase crop production, more financial returns per unit land area and to improve resource use efficiency at Farm level (Tang et al., 2021). The addition of the crop residues of intercrop in soil will improve the level of organic matter and soil fertility (Liu et al., 2021). Organic matter and soil fertility have become foremost concerns for sustainable agriculture and crop production. Pulse crops like lentil, gram have the

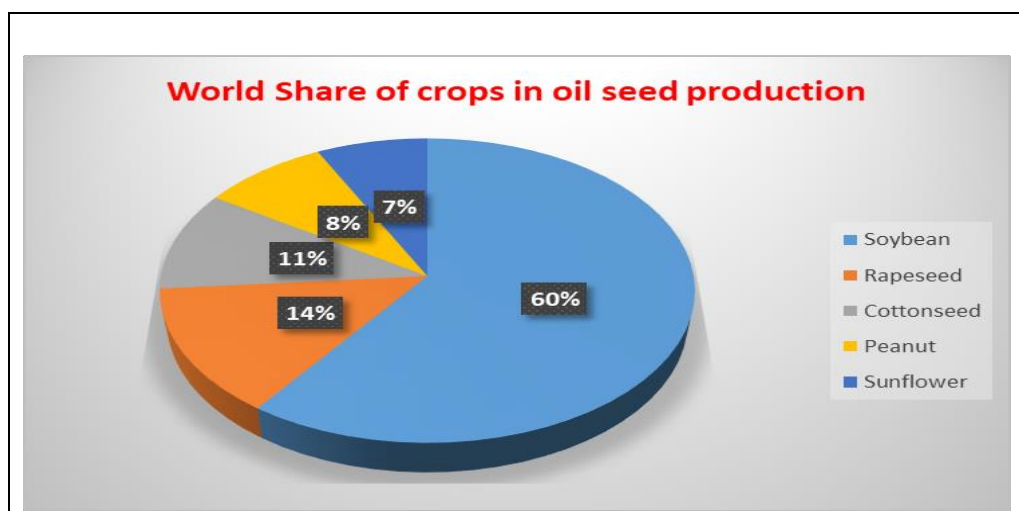
opportunities to improve the crop productivity in sugarcane cropping system. It reduce the cost of production and improve soil fertility level on sustainable basis (Parsons, 2003).

Canola is a type of rapeseed (*Brassica napus*, *Brassica rapa*, and *Brassica juncea* of canola quality) having improved quality with reduced erucic acid content in the oil (must be less than 2%) (R.E. Abdelraouf et al., 2021) and glucosinolate content in the meal. Canola contains 38% protein and 40% vegetable oil. It is used as high-quality animal feed and industrial oils. In world soybean contributes 57%, Rapeseed 13% cottonseed 10% in world production of oilseeds (Table-2). It is second-largest oilseed crop in world. In Canada more than 99% canola produced is of *Brassica napus* species (Mustafa et al., 2018).

In intercropping Land equivalent ratio is of great importance. It indicates the efficiency of various intercrops in using planth growth sources as compared with mono / sole crop (Navneet et al., 2016). It presents the the advantages and effeciency of using intercrops in sustainable agriculture in modern era. Increase in global world population demands efficient utilization of all available farm resoruces. If the value of LER in intercropping trial is more than one it means intercropping is more effective and effecient for plant growth factors and for effecient utilization of light, water and nitrogen than sole / mono crop (Liu et al., 2021).

It was also shown in studies that greater amounts of phosphorus and potassium were taken up from intercropping soil than from the monoculture (Castioni et. al., 2018).In an experiment consisting of three cropping systems and six weed control treatments were investigated and found that canola is suitable for intercropping in autumn sugarcane along with adequate weed suppression than weedy check. It was also found that Pre-emergence application of herbicide is beneficial for intercropping success (Navneet et al., 2016).

Table-3 World Major oil seed production



Sugarcane crop grow gradually in early growth stage and hence accommodate easily the short duration (Khaliq et al., 2020) and quick maturing crops (Liu et al., 2021). It takes early three months for canopy expansion and development in autumn plantation (Parsons 2003). Multiple cropping yields an opportunity of best exploitation and utilization the available space of two feet between cane rows (Navneet et al., 2016). Cane growers may raise numerous short duration crops

and obtain financial benefits (Degefa et al., 2016). Ultimately, it will improve region's socioeconomic conditions (Seran and Brintha, 2010).

Intercropping improves the land use efficiency and boosts microbial activities in soil. Among three intercropping systems viz. sugarcane alone, peanut, soybean intercrops, bacterial communities were found correlated positively with soil pH (Cong et al., 2015). The availability of Phosphorus in the soil of intercrops in better quantity showed a resilient link between uptake of soil nutrients and microbes activities (Tang et al., 2021). In the world, soybean intercropping in sugarcane was discovered as a stable and sustainable scheme as compared to mono-system. It has potential for the augmentation of productivity over time and space in subsistence farming (Khan et al., 2014) because of high utilization efficiency of light, stability of yields, and resilience to biotic and abiotic stresses and reduction of Nitrogen losses through leaching (Castioni et. al., 2018).

The conventional method of planting cane does not permit the intercrops to grow well due to shading and competition effect (Rehman et al., 2014). Intercropping is the farm management technique (Shukla et al., 2017) in which the available space between 4 feet apart dual row are well and judiciously utilized to boost interim short term financial return to the farmers (Akhter et al., 2004). In this view this experiment was planned and conducted to optimize the planting technique of canola intercropping system best suited for sugarcane growers in Pakistan.

Materials and Methods

The experiment was piloted at research and farm area of Sugarcane Research Institute, Faisalabad, Pakistan during autumn of the crop season 2019-20 to work out the feasibility and scope of suitable planting technique of canola intercrop for sugarcane for increasing the cropping intensity and profitability and to determine the effect of different planting technique of canola intercrop on yield and economics of autumn planted sugarcane. The net plot size was 8 m × 8.4 m a randomized complete block design with five replications. The sugarcane clone CPF-252 was used and seed was planted in September each year at the rate of 50,000 triple budded setts per hectare, on four feet apart double row strips. The treatments includes:

- T1: Sugarcane apart 2.5ft rows +broad cast of canola
- T2: Sugarcane apart 2.5ft rows +1 line of canola
- T3: Canola alone
- T4: Sugarcane apart 4ft rows +broad cast of canola
- T5: Sugarcane apart 4ft rows +1 line of canola
- T6: Sugarcane apart 4ft rows +2 line of canola
- T7: Sugarcane alone

Half seed rate 5 kg per hectare of Faisal Canola was used as intercrop. One / two lines of intercrops were sown on ridges as per treatments. Intercrops were harvested at maturity while the sugarcane crop was harvested in the month of December each year. NPK Fertilizer was applied at the rate of 169, 112 and 112 kg per hectare respectively in the form of urea, DAP, SOP. Fifteen irrigations were applied at different intervals according to the crop need and weather conditions. Crop was harvested at maturity from each plot and cane yield per hectare was valued. Net return was worked out by deducting the total cost of production from the gross income of each treatment (CIMMYT,

1988). The data were put to Fisher's analysis of variance and treatment means were compared to find the differences by using LSD test at 0.05% probability (Steel et al., 1984).

Results and Discussion

RESULTS:

It was revealed from the data presented in table-1 that canola intercropping did not affect significantly the germination, tillering capacity and sugar recovery of sugarcane crop. On the other hand number of canes, cane yield and sugar yield is statistically affected by the intercrop. The highest cane count (110 thousand/ha), cane yield (103.30 t/ha) and sugar yield (12.96 t/ha) was obtained in T6-sugarcane apart 4ft rows +2 line of canola. The treatment T6 is at par with treatment T7- Sugarcane alone. These parameters were found at lowest in treatment T1- sugarcane apart 2.5ft rows +broad cast of canola presenting cane count (57 thousand/ha), cane yield (49.50 t/ha) and sugar yield (6.14 t/ha)

The economics of canola sugarcane intercropping was calculated in Table-2. It was found that the highest sugarcane income of Rs. 464850/- was found in T6- Sugarcane apart 4ft rows +2 line of canola which is followed by T7 having sugarcane income of Rs. 431100/- and T4- Sugarcane apart 4ft rows +broad cast of canola with income of Rs. 373500/-. The lowest income of Rs. 222750/- was obtained in T1- Sugarcane apart 2.5ft rows +broad cast of canola.

As regarding with intercrop yield, highest canola yield of 2.35 t ha was found in T1- Sugarcane apart 2.5ft rows +broad cast of canola which is followed by T4- Sugarcane apart 4ft rows +broad cast of canola having canola yield of 1.98 t ha and T3- Canola alone with 1.92 t ha canola yield. The lowest canola yield of 1.06 t ha was obtained in T5- Sugarcane apart 4ft rows +1 line of canola followed by T6- Sugarcane apart 4ft rows +2 line of canola.

In intercrop income, highest canola income of Rs. 131600/- was found in T1- Sugarcane apart 2.5ft rows +broad cast of canola which is followed by T4- Sugarcane apart 4ft rows +broad cast of canola having canola income of Rs. 110880/- and T3 with Rs. 107520/- canola income. The lowest canola income of Rs. 59360/- was obtained in T5- Sugarcane apart 4ft rows +1 line of canola followed by T6-Sugarcane apart 4ft rows +2 line of canola.

Among total income, the highest total income of Rs. 524210/- was found in T6- Sugarcane apart 4ft rows +2 line of canola which is followed by T4- Sugarcane apart 4ft rows +broad cast of canola having sugarcane income of Rs. 484380/- and T7-Sugarcane alone with income of Rs. 431100/-. The lowest income of Rs. 107520/- was obtained in T3- Canola alone.

The cost of sugarcane production of Rs. 175000/- ha is constant for all treatments while cost of production of canola is Rs.4000 in intercrop treatments and Rs. 24680/- in canola alone treatment. The total cost of production of Rs. 179000/- was tabulated in all treatment except canola alone of Rs. 24680/- and sugarcane alone of Rs. 175000/-.

Table: 1 Effect of Canola Inter crop planting techniques on Yield and quality of Sugarcane

Sr.no	Treatment	Germination (%)	Tillers /plant	Cane account (000/ha)	Cane yield (t/ha)	Sugar recovery (%)	Sugar yield (t/ha)
1	T1-sugarcane apart 2.5ft rows +broad	52	2.10	57 E	49.50 E	12.41	6.14 E

	cast of canola						
2	T2-sugarcane apart 2.5ft rows +1 line of canola	50	2.20	73 D	60.90 D	12.45	7.58 D
3	T3-canola alone	0	0	0	0	0	0
4	T4-sugarcane apart 4ft rows +broad cast of canola	46	1.95	90 C	83.00 C	12.22	10.14 B
5	T5-sugarcane apart 4ft rows +1 line of canola	47	2.25	85 C	79.40 C	12.11	9.62 C
6	T6-sugarcane apart 4ft rows +2 line of canola	51	2.08	110 A	103.30 A	12.55	12.96 A
7	T7-sugarcane alone	50	2.50	100 B	95.80 B	12.75	12.21 A
	LSD 0.05	N.S	N.S	7.8995	5.8425	N.S	1.2855

The highest net income of Rs. 345210/- was found in T6- Sugarcane apart 4ft rows +2 line of canola followed by T4- Sugarcane apart 4ft rows +broad cast of canola with net income of Rs. 305380/-. While the lowest net income of Rs. 82840/- was found in T3- Canola alone.

The highest BCR value of 3.35 was found in T3- Canola alone followed by T6-Sugarcane apart 4ft rows +2 line of canola with BCR value of 1.93. While the lowest BCR value of 0.95 was found in T2- Sugarcane apart 2.5ft rows +1 line of canola.

DISCUSSION:

Intercropping is an agricultural technique of cultivating and sowing two or more than two crops in the same space of field at the same time. Here the aim is to match crop demands resourcefully and efficiently to the available growth resources, nutrients, light and labor. It supports in sustaining the soil health and fertility and making efficient consumption of nutrients and make sure cost-effective exploitation and utilization of land, capital resources and labor.

Sugarcane is widely spaced crop in appraisal by other field crops. It is a long duration crop offering a pronounced opportunity for using cane interspace through growing short duration intercrops. In intercropping, implementation of sustainable planting geometry is of key importance for obtaining optimum plant population of companion intercrops.

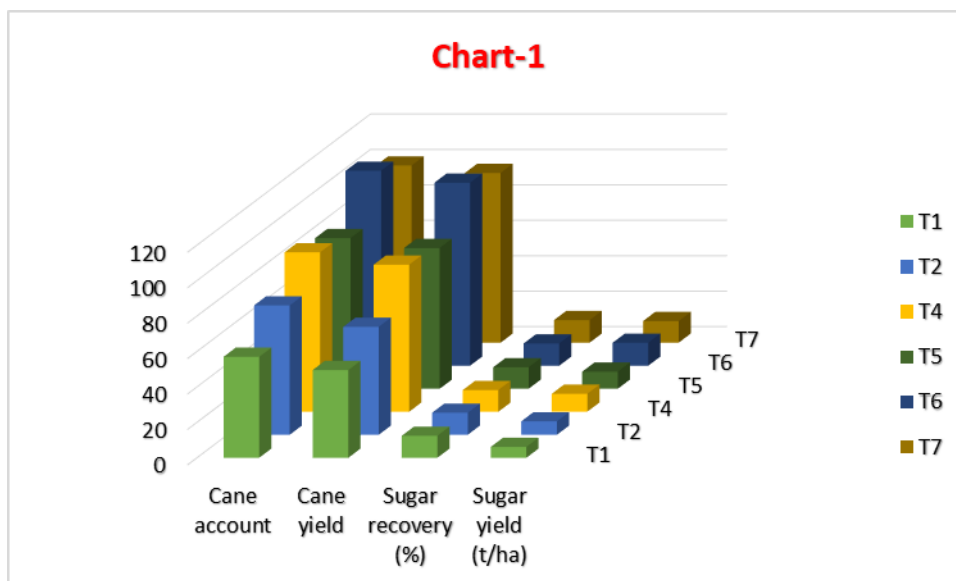
Treatments	Sugarcane yield (t/ha)	Canola yield (t/ha)	Sugarcane Income Rs.	Canola Income Rs.	Total income Rs.	Cost of production of sugarcane Rs.	Cost of protection of canola Rs.	Total cost Rs.	Net income Rs.	BCR
T1	49.5	2.35	222750	131600	354350	175000	4000	179000	175350	0.98

T2	60.9	1.36	274050	76160	350210	175000	4000	179000	171210	0.95
T3	-	1.92	-	107520	107520	-	24680	24680	82840	3.35
T4	83.0	1.98	373500	110880	484380	175000	4000	179000	305380	1.71
T5	79.4	1.06	357300	59360	416660	175000	4000	179000	237660	1.33
T6	103.3	1.06	464850	59360	524210	175000	4000	179000	345210	1.93
T7	95.8	-	431100	-	431100	175000	-	175000	256100	1.46
Price Sugarcane @ Rs.180/40Kg Price Canola @ Rs. 56/Kg										

In the sugar industry, high cost of production and less profit is main constrain in economical and profitable sugarcane production in developing countries like Pakistan. Therefore, intercropping is reflected as a management possibility, particularly for small land holder farmers with inadequate inputs and land resources (Liu et al., 2021). In this study highest sugarcane yield of 103.3 t ha was found in T6- Sugarcane apart 4ft rows +2 line of canola which is followed by T7- Sugarcane alone having sugarcane yield of 95.8 t ha and T4- Sugarcane apart 4ft rows +broad cast of canola with 83 t ha sugarcane yield. The lowest sugar cane yield of 49.5 t ha was obtained in T1- Sugarcane apart 2.5ft rows +broad cast of canola. Similar results were obtained by Liu et al., (2021).

The highest sugarcane income of Rs. 464850/- was found in T6- Sugarcane apart 4ft rows +2 line of canola which is followed by T7 having sugarcane income of Rs. 431100/- and T4- Sugarcane apart 4ft rows +broad cast of canola with income of Rs. 373500/-. The lowest income of Rs. 222750/- was obtained in T1- Sugarcane apart 2.5ft rows +broad cast of canola. These results are in line with Castioni et al (2008). In the world, soybean intercropping in sugarcane was discovered as a stable and sustainable scheme as compared to mono-system. It has potential for the augmentation of productivity over time and space in subsistence farming because of high utilization efficiency of light, stability of yields, and resilience to biotic and abiotic stresses and reduction of Nitrogen losses through leaching.

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The cost of sugarcane production of Rs. 175000/- ha is constant for all treatments while cost of production of canola is Rs.4000 in intercrop treatments and Rs. 24680/- in canola alone treatment. The total cost of production of Rs. 179000/- was tabulated in all treatment except canola alone of Rs. 24680/- and sugarcane alone of Rs. 175000/-. The results of studies on intercropping shown that intercropping of mustard and potato improve the microbial diversity, crop productivity and soil quality. Highest cane yield, microbial activities, microbial count, microbial biomass, total carbon, nitrogen and available micronutrients N, CU, Fe, Zn and cation exchange capacity was found in sugarcane plant crop, mustard, sugarcane ratoon, cow pea cropping system (Cong et al., 2015).

The highest net income of Rs. 345210/- was found in T6- Sugarcane apart 4ft rows +2 line of canola followed by T4- Sugarcane apart 4ft rows +broad cast of canola with net income of Rs. 305380/-. While the lowest net income of Rs. 82840/- was found in T3- Canola alone. The highest BCR value of 3.35 was found in T3- Canola alone followed by T6-Sugarcane apart 4ft rows +2 line of canola with BCR value of 1.93. While the lowest BCR value of 0.95 was found in T2- Sugarcane apart 2.5ft rows +1 line of canola. These results are in line with Rehman et al., (2014) who stated that exhaustive inter crops decline cane yield and net benefit.

It was also shown in studies that greater amounts of phosphorus and potassium were taken up from intercropping soil than from the monoculture. The results of a study in south china point out

that the sugarcane-pea intercropping boosted the content of total nitrogen, available phosphorus, total potassium, organic matter, pH value and bacteria and enhanced the activity of acid phosphatase compared to sole cropping by increasing the contents of available nitrogen (20.1%), phosphorus (65.3%) and organic matter (56.0%) in root zone soil of sugarcane pea treatment along with more abundant quantity of genes related to Nitrogen and phosphorus metabolism / cycling over mono-cropping and this intercrop maximizes the tonnage of sugarcane crop (Tang et al., 2021) .

The economics of the treatments were also calculated (table 2) were compared with the sugarcane mono-cropping system. The data discovered that h economic advantage of Rs. 345210/- ha⁻¹ with benefit cost ratio of 1.93 was high and found in the treatments where two lines of canola sugarcane intercropping model was adopted. Then economic advantage of Rs. 264700/- ha⁻¹ was received in two rows of Mung Intercrop- Sugarcane model with BCR of 1.47. The lowest benefit of Rs. 80386/- ha⁻¹ was produced where two lines of sunflower was sown as intercrop with minimum BCR of 0.44.

CONCLUSION:

Two lines of canola intercropped in four feet apart dual row sown sugarcane (recommeded planting practice) will be more feasible, ease to do, economical and profitable than traditional planting geometry and is more sustainable way in profitable agriculture.

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