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Performance and Economics of Sweet Corn as Influenced by Leafy Vegetables Intercropping System under Protective Irrigated Condition

R. Vidhyashree[1*], M.B. Patil[1], A.K. Guggari[1] and A.P. Biradar[2]

[1]*Department of Agronomy, College of Agriculture, Vijayapura-586108, India*
[2]*Department of Agricultural Entomology, College of Agriculture, Vijayapura-586108, India*

**Corresponding author*

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A B S T R A C T

The present investigation was undertaken during *Kharif* 2018 at the college of Agriculture, Vijayapura, University of Agricultural Sciences, Dharwad (Karnataka). The objective of this study was to study the effect of different vegetables intercrops on growth, yield and economics of sweet corn and vegetable intercropping systems. The experiment was laid out in Randomized Block Design with three replications and ten treatments. These ten treatments comprised of sweet corn as a base crop and fenugreek, spinach, Amaranthus and dill as intercrops. The sole sweet corn (90 cm × 20 cm) recorded significantly higher growth parameters namely leaf area and LAI at different phenological stages. Significantly higher fresh cob yield (184 q ha^{-1}) and green fodder yield (295 q ha^{-1}) was recorded by sole sweet corn (90 cm × 20 cm). The increase in fresh cob yield and green fodder yield with sole sweet corn (90 cm × 20 cm) could be the maximum length of cob (24.30 cm), girth of cob (10.73 cm), cob weight (403.33 g/cob) and number of kernels per cob (597) over the rest of the treatments. The Sweet corn (90 cm × 20 cm) + fenugreek intercropping system in 1:2 row proportion was the most remunerative with net returns (₹ 328178 ha^{-1}) and B: C (8.67) over the rest of the intercropping systems.

Introduction

Sweet corn is one of the most popular types for human consumption among different types of corn grown. It is peculiarly an American crop. Origin of sweet corn is considered as Peru, Bolivia and Equador. Sweet corn has been bred to have higher levels of natural sugar, which makes it very popular. It is hybridized maize, specially bred to increase sugar content and also known as “sugar corn”. Vegetable as an intercrop provides leafy vegetable under rainfed situation within short duration which gives more monetary returns than any other short duration agronomical crop as demand of vegetables during the rainy season is more. Fenugreek commonly known as methi is cultivated throughout India which is used for cooking, salad and fodder purpose. Spinach is one of the most common vegetables of tropical and subtropical region and is grown widely in India. Leaves are rich in vitamin A, C, calcium, etc. coriander is used as common flavouring substance. Its leaves are used for flavouring curries, sauces and soups. Garlic leaves are rich in proteins, phosphorus, potassium, calcium, magnesium, carbohydrates and used for cooking purpose. Intercropping is a type of mixed cropping and defined the agricultural practice of cultivating two or more crops in the same space at the same time (Andrew and Kassam, 1976). Intercropping is much more scientific, rational and refined concept than traditional practice of mixed cropping. Although intercropping is not now new concept it has attracted worldwide attention due to its various advantages. It was originally practiced as an insurance against crop failure under rainfed conditions. Risk may be minimized in intercropping (Woolley and Davis, 1991). Biological efficiency of intercropping due to exploration of large soil mass compared to monocropping (Francis, 1989). This advanced agrotechnique has been practiced in past decades and achieved the goal of agriculture. There are some socio-economic (Ofori and Stern, 1987), biological and ecological advantages (Fininsa, 1996) in intercroping over monocropping. Several scientists have been worked with intercropping (Brintha and Seran, 2009). At present its main objective is higher productivity per unit area in addition to stability in production in rainfed situation where uncertainly and ill distribution of rainfall, monocropping becomes risky. By considering the detail study, present investigation was planned with objectives as to study the effect of different vegetables intercrops on growth, yield and economics of sweet corn and vegetable intercropping systems

Materials and Methods

A Field experiment was conducted during *kharif* 2018 at College of Agriculture, Vijayapura, University of Agricultural Sciences, Dharwad (Karnataka). It is located in Vijayapura district in the northern part of Karnataka State at 16^0 49' North latitude, 75^0 43' East longitude and at an altitude of 593.8 m above the mean sea level. The topography of the experiment plot was uniform. The selection of site was considered on the basis of suitability of the land for cultivation of sweet corn and different intercrops. The field experiment was laid out in Randomized block design comprising of ten treatments replicated thrice *viz.*, $T_{1:}$ Sole sweet corn (60 cm × 20 cm), T_2: Sole sweet corn (90 cm × 20 cm), $T_{3:}$ Sweet corn (60 cm × 20 cm) + dill (1:1), T_4: Sweet corn (60 cm × 20 cm) + spinach (1:1), T_5: Sweet corn (60 cm × 20 cm) + amaranthus (1:1), $T_{6:}$ Sweet corn (60 cm × 20 cm) + fenugreek (1:1), T_7: Sweet corn (90 cm × 20 cm) + dill (1:2), T_8: Sweet corn (90 cm × 20 cm) + spinach (1:2), T_9: Sweet corn (90 cm × 20 cm) + amaranthus (1:2), T_{10}: Sweet corn (90 cm × 20 cm) + fenugreek (1:2). Soil of the experimental site was clayey in texture, slightly alkaline in nature having moderate organic carbon content, low available nitrogen, medium available phosphorus and high available potassium.

Results and Discussion

Growth attributes

Photosynthetic parameters like leaf area and leaf area index differed significantly at all growth stages of sweet corn intercropped with leafy vegetables. The sole sweet corn (90 cm × 20 cm) registered with significantly higher leaf area (7.95, 29.94 and 81.11 dm^2 at 20, 40 and 60 DAS, respectively) as compared to sweet corn (60 cm × 20 cm) + spinach (1:1) intercropping system which was recorded significantly lower leaf area (3.47, 13.92 and 38.39 dm^2 at 20, 40 and 60 DAS, respectively) (Table 1). With respect to leaf area index the sole sweet corn (60 cm × 20 cm) which recorded the higher leaf area index (0.43,1.69 and 4.71 at 20, 40 and 60 DAS, respectively) as compared to sweet corn (60 cm × 20 cm) + spinach (1:1) intercropping system (0.29, 1.16 and 3.20 at 20, 40 and 60 DAS, respectively)

(Table 2). These results corroborate the findings of Hossain *et al.,* (2015) and Chaudhari *et al.,* (2018). Plant canopies intercept light with varying degrees of efficiency associated chiefly with the LAI. The efficiency of intercepting of incident light, combined with efficiency of photochemical reactions of the leaves determine the efficiency of the canopy in utilizing radiation energy per unit of land area.

Yield and yield attributes

The present study revealed that, sole sweet corn sown at 90 cm × 20 cm spacing recorded significantly higher fresh cob yield (184 q ha^{-1}) over the rest of the treatments. The increase in fresh cob yield was 50.5 percent over the intercropping of spinach at 1:1 row proportion with sweet corn sown at 60 cm inter row spacing (Table 3). The increment in the fresh cob yield of sweet corn was due to higher yield attributing characteristics *viz.,* cob length, cob girth, cob weight and number of kernels per cob, these results are in line with the findings of Hossain *et al.,* (2015).

Significantly higher green fodder yield (295 q ha^{-1}) was recorded in sole sweet corn (90 cm × 20 cm) over the rest of the treatments. The increase in green fodder yield with sole sweet corn (90 cm × 20 cm) was 46.5 per cent over the intercropping of spinach at 1:1 row proportion with sweet corn sown at 60 cm interrow spacing (Table 4 and Fig. 1).

The higher fresh cob yield and green fodder yield of sweet corn was mainly due to no biological competition for basic resources, exerted by the component crop in the sole crop for the growth resources during various stages of the crop growth and which leads to better translocation of photosynthates from source to sink and higher growth attributing characters like higher number of leaves, leaf area and higher dry matter production and its accumulation into different parts of plant and yield attributing characters like cob length and girth, cob weight and number of kernels per cob. The results are in conformity with the findings of Chaudhari *et al.,* (2018) and Hossain *et al.,* (2015) in maize + winter vegetables intercropping with different row proportions.

The higher yield performance in sole sweet corn (90 cm × 20 cm) may be due to higher values of yield attributes (Table 3), namely length of cob (24.30 cm), girth of cob (10.73 cm), cob weight (403.33 g/cob) and number of kernels per cob (597). This may be assigned to availability of good micro climate and area availability to the crop for nourishment is high as there is no inclusion of intercrop, per unit area more vegetative and the total biological competition among each plant were minimum. Similar kinds of result are also reported by Madhu (2013) in maize and intercropping system with different row proportions.

Economics

The economic returns measure the profitability of a system. The farmers adopt only such practices that are more profitable and viable over longer period. The data on the total cost, gross income, net income and B: C as influenced by different treatments are presented in Table 5. The net returns differed significantly due to intercropping systems. Sweet corn (90 cm × 20 cm) + fenugreek intercropping system in 1:2 row proportion was the most remunerative with net returns (₹ 328178 ha^{-1}) as compared to other treatments.

The increase in net returns was 36.6 percent over the sole sweet corn (60 cm × 20 cm). This is due to lower cost of cultivation and higher market price of fenugreek as compared to other intercropping systems. Similar kind of results has also been reported by Vilhekar *et al.,* (2014) in sweet corn + leafy vegetables intercropping systems.

Table.1 Leaf area per plant at different growth stages of sweet corn as influenced by intercropping with leafy vegetables

Treatments	Leaf area (dm^2) per plant			
	20 DAS	40 DAS	60 DAS	At harvest
T_1-Sole sweet corn (60 cm × 20 cm)	5.18	20.33	56.55	28.64
T_2-Sole sweet corn (90 cm × 20 cm)	7.95	29.94	81.11	51.82
T_3-Sweet corn (60 cm × 20 cm) + Dill (1:1)	4.47	17.40	48.12	23.11
T_4-Sweet corn (60 cm × 20 cm) + Spinach (1:1)	3.47	13.92	38.39	17.40
T_5-Sweet corn (60 cm × 20 cm) + Amaranthus (1:1)	4.02	15.67	45.72	21.26
T_6-Sweet corn (60 cm × 20 cm) + Fenugreek (1:1)	4.73	18.43	52.02	27.28
T_7-Sweet corn (90 cm × 20 cm)+ Dill (1:2)	6.50	24.13	65.21	37.75
T_8-Sweet corn (90 cm × 20 cm) + Spinach (1:2)	5.28	21.49	59.22	31.31
T_9-Sweet corn (90 cm × 20 cm)+ Amaranthus (1:2)	5.78	23.69	61.52	32.93
T_{10}-Sweet corn (90 cm × 20 cm)+ Fenugreek (1:2)	6.90	25.29	69.54	40.88
S.Em. ±	0.60	1.56	3.39	1.86
C.D. (P=0.05)	1.81	4.74	10.27	5.64

Table.2 Leaf area index at different growth stages of sweet corn as influenced by intercropping with leafy vegetables

Treatments	Leaf area Index			
	20 DAS	40 DAS	60 DAS	At harvest
T_1-Sole sweet corn (60 cm × 20 cm)	0.43	1.69	4.71	2.87
T_2-Sole sweet corn (90 cm × 20 cm)	0.44	1.66	4.51	2.38
T_3-Sweet corn (60 cm × 20 cm) + Dill (1:1)	0.37	1.45	4.07	1.93
T_4-Sweet corn (60 cm × 20 cm) + Spinach (1:1)	0.29	1.16	3.20	1.45
T_5-Sweet corn (60 cm × 20 cm) + Amaranthus (1:1)	0.33	1.28	3.81	1.77
T_6-Sweet corn (60 cm × 20 cm) + Fenugreek (1:1)	0.39	1.54	4.33	2.27
T_7-Sweet corn (90 cm × 20 cm)+ Dill (1:2)	0.36	1.34	3.62	2.10
T_8-Sweet corn (90 cm × 20 cm) + Spinach (1:2)	0.29	1.19	3.25	1.74
T_9-Sweet corn (90 cm × 20 cm)+ Amaranthus (1:2)	0.32	1.32	3.42	1.83
T_{10}-Sweet corn (90 cm × 20 cm)+ Fenugreek (1:2)	0.38	1.42	3.86	2.27
S.Em. ±	0.03	0.08	0.20	0.17
C.D. (P=0.05)	0.09	0.26	0.61	0.52

Table.3 Yield attributes of sweet corn as influenced by intercropping with leafy vegetables

Treatments	Yield attributes of sweet corn			
	Cob length (cm)	Cob girth (cm)	Cob weight (g cob^{-1})	Number of kernels per cob
T_1-Sole sweet corn (60 cm × 20 cm)	20.27	8.83	351.67	557.00
T_2-Sole sweet corn (90 cm × 20 cm)	24.30	10.73	403.33	597.00
T_3-Sweet corn (60 cm × 20 cm) + Dill (1:1)	19.37	8.17	335.33	534.33
T_4-Sweet corn (60 cm × 20 cm) + Spinach (1:1)	17.34	7.40	321.33	509.00
T_5-Sweet corn (60 cm × 20 cm) + Amaranthus (1:1)	18.87	7.73	330.67	525.67
T_6-Sweet corn (60 cm × 20 cm) + Fenugreek (1:1)	20.00	8.47	341.33	546.33
T_7-Sweet corn (90 cm × 20 cm)+ Dill (1:2)	23.43	10.33	382.00	578.33
T_8-Sweet corn (90 cm × 20 cm) + Spinach (1:2)	21.00	9.63	362.00	568.33
T_9-Sweet corn (90 cm × 20 cm)+ Amaranthus (1:2)	22.97	10.00	370.67	570.33
T_{10}-Sweet corn (90 cm × 20 cm)+ Fenugreek (1:2)	23.83	10.40	392.00	588.33
S.Em. ±	1.29	0.73	17.46	17.91
C.D. (P=0.05)	3.92	2.20	52.97	54.34

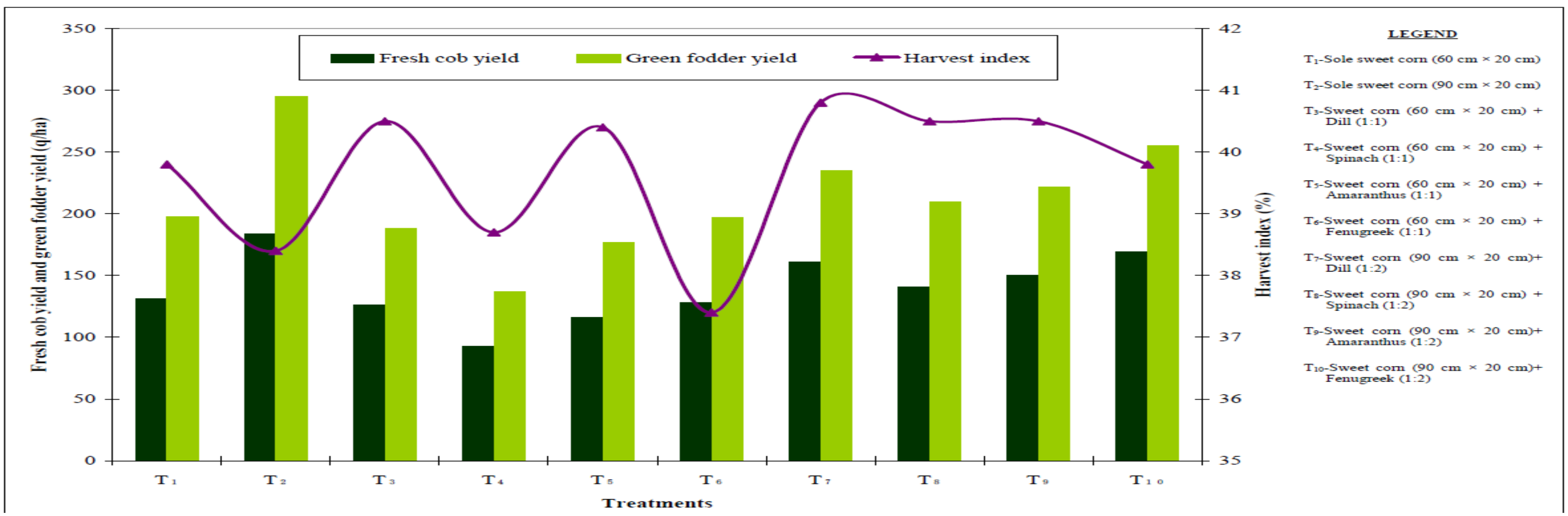
Table.4 Fresh cob yield, green fodder yield and harvest index of sweet corn as influenced by intercropping with leafy vegetables

Treatments	Fresh cob yield (q ha^{-1})	Green fodder yield (q ha^{-1})	Harvest index (%)
T_1-Sole sweet corn (60 cm × 20 cm)	131	198	39.8
T_2-Sole sweet corn (90 cm × 20 cm)	184	295	38.4
T_3-Sweet corn (60 cm × 20 cm) + Dill (1:1)	126	188	40.5
T_4-Sweet corn (60 cm × 20 cm) + Spinach (1:1)	93	137	38.7
T_5-Sweet corn (60 cm × 20 cm) + Amaranthus (1:1)	116	177	40.4
T_6-Sweet corn (60 cm × 20 cm) + Fenugreek (1:1)	128	197	37.4
T_7-Sweet corn (90 cm × 20 cm)+ Dill (1:2)	161	235	40.8
T_8-Sweet corn (90 cm × 20 cm) + Spinach (1:2)	141	210	40.5
T_9-Sweet corn (90 cm × 20 cm)+ Amaranthus (1:2)	150	222	40.5
T_{10}-Sweet corn (90 cm × 20 cm)+ Fenugreek (1:2)	169	255	39.8
S.Em. ±	17	23	3.51
C.D. (P=0.05)	52	71	NS

Table.5 Economic evaluation of sweet corn based intercropping system

Treatments	Gross returns (₹ ha^{-1})	Net returns (₹ ha^{-1})	B:C
T_1-Sole sweet corn (60 cm × 20 cm)	151227	107859	3.49
T_2-Sole sweet corn (90 cm × 20 cm)	253714	216562	6.83
T_3-Sweet corn (60 cm × 20 cm) + Dill (1:1)	223504	176079	4.71
T_4-Sweet corn (60 cm × 20 cm) + Spinach (1:1)	280823	230293	5.56
T_5-Sweet corn (60 cm × 20 cm) + Amaranthus (1:1)	284968	235959	5.81
T_6-Sweet corn (60 cm × 20 cm) + Fenugreek (1:1)	282678	234254	5.84
T_7-Sweet corn (90 cm × 20 cm)+ Dill (1:2)	306965	265397	7.38
T_8-Sweet corn (90 cm × 20 cm) + Spinach (1:2)	339204	293823	7.47
T_9-Sweet corn (90 cm × 20 cm)+ Amaranthus (1:2)	329428	285919	7.57
T_{10}-Sweet corn (90 cm × 20 cm)+ Fenugreek (1:2)	370968	328178	8.67
S.Em. ±	16746	16746	0.35
C.D. (P=0.05)	50799	50799	1.07

Fig.1 Fresh cob yield, green fodder yield and harvest index of sweet corn as influenced by intercropping with leafy vegetables



Among all the intercropping systems, sweet corn (90 cm × 20 cm) + fenugreek (8.67) recorded significantly higher B:C than the sole sweet corn (60 cm × 20 cm) which recorded significantly lower B: C (3.49) (Table 5). The increase in the B: C was 44.3 percent over the sole sweet corn (60 cm × 20 cm). This was mainly due to the lower cost of cultivation incurred and higher gross returns realised, compared to other treatments. Similar results of higher B: C was reported by Mian *et al.*, (2011) in maize + leafy vegetables intercropping system.

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