

Potential for vegetable intercropping with maize in winter season

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Abstract: A two-year field experiment (2018-19 and 2019-20) revealed that intercropping of winter maize (*Zea mays* L.) As far as various intercropping indices depicting economic feasibility of the system concerned, maize equivalent yield and land equivalent ratio was significantly highest in maize intercropped with cauliflower (1:1) followed by maize intercropped with spinach (1:3), maize intercropped with garlic (1:1), maize intercropped with potato (1:1), maize intercropped with cabbage (1:1), maize intercropped with coriander (1:3), maize intercropped with green pea (1:1) and maize intercropped with fenugreek (1:3). Maximum net returns and B:C ratio was obtained in intercropping as compared to sole maize crop.

Keywords: Intercropping · Winter maize · Maize equivalent yield · Cauliflower · Spinach · Garlic · Potato · Cabbage · Coriander · Green pea · Fenugreek · Benefit-cost ratio

Introduction

Maize is one of the most important cereal crops next to wheat and rice in the world. Globally, it is known as queen of cereals because it has the highest genetic yield potential among the cereals. At worldwide, it was cultivated on an area of 200.0 million hectares and recorded the production of 1163 million tonnes of grains with an average grain yield of 58.2 q ha⁻¹. In India, maize is grown on 9.9 million-hectare area with 31.7 million tonnes of production and average grain yield of 32.1 q ha⁻¹ (FAO, 2022). Winter

maize has shown its higher yield potential as compared to other cereals, pulses and oilseeds. Intercropping of vegetable with maize make *rabi* maize more profitable as compared to sole maize. Substantial advantage in yield from intercropping compared with sole cropping occurs from complementary effect of different crops on each other, making better use of resources when grown together. The winter maize favourably responds to better crop management (Singh, 2000). Choudhary *et al.* (2015) revealed that Intercropping of maize with winter vegetable with different row pattern appeared an efficient and economically viable system, giving the highest maize grain yield, maize equivalent yield and production efficiency. Similar results were also obtained by different worker at different places under sole winter maize treatment maize equivalent yield decreased significantly than its equivalent yield under maize based inter cropping system. In Haryana winter maize become more popular owing to high productivity. Unfavourable factors like erratic distribution of rainfall, unfilled cobs, infestation of diseases, insect-pest, weeds are the responsible for the low yield of maize (*Zea mays* L.) in the rainy season. However, these factors show less effect in the winter season. Hence, this offers yet another possibility of substantially increasing the production potential of winter maize. The growth of maize crop up to the middle of December remains normal and thereafter due to low temperature it almost ceases till middle of February. Therefore, during this phase there is ample scope for growing intercrops in between the rows of maize to get more returns from a unit area of land. There are many winter vegetable crops which may be suitably adjusted in between the winter maize. Maize as wider spaced plant offers some component crops to grow together without economic loss sacrificing small maize yield with greater total production in respect of land and time. Singh *et al.* (2017) also reported that in peri urban

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interface intercropping in *rabi* season with maize is more profitable systems are also gaining importance due to market driven farming. This practice offered considerable yield advantages and higher economic return over sole intercropping because of its efficient utilization of growth resources (Faruque *et al.*, 1996). Hence, present study was undertaken to obtain information best suited intercropping system of winter maize for increasing total productivity, return and maximize land utilization.

Materials and methods

A field investigation was carried out during the winter season of 2018-19 and 2019-20 at Regional Research Station, CCS HAU, Karnal which is located at latitude of 29° 31' 42.19" N longitude of 76° 58' 49.88" E and at an altitude of 253 meters above mean sea level. The soil of experiment plot was clay loam in texture, low in organic carbon (0.39%), slightly alkaline (8.4 pH) in reaction, low in available N (166.0 kg/ha), medium in available P (7.0 kg/ha) and K rich in (152 kg/ha). The experiment consisted of thirteen treatments; namely Maize + Potato T₁ (1:1), Sole potato T₂, Maize + Green pea (1:1) T₃, Sole green pea T₄, Maize: fenugreek (1:3) T₅, Sole: fenugreek T₆, Maize: Spinach (1:3) T₇, Sole spinach T₈, Maize: Coriander (1:3) T₉, Sole coriander T₁₀, Maize: Cauliflower (1:1) T₁₁, Sole Cauliflower T₁₂, Maize: cabbage (1:1) T₁₃, Sole cabbage T₁₄, Maize: Garlic (1:3) T₁₅, Sole garlic T₁₆ and sole maize with row spacing of 75 cm, respectively were laid out in factorial randomized block design with three replication, having plot size of 6.0 × 4.0 m². The sole crop of maize and intercropping association was sown on 26 October during the both year (*rabi* 2018-19 and *rabi* 2019-20). Recommended fertilizer dose of maize (180, 60, 60 kg N, P and K/ha) and recommended dose of fertilizer respective intercrops were given separately. The trial data were analysed by using OPSTAT software which is available on CCS Haryana Agricultural University official site (Sheoran, 2016). Equivalent yield of component crops were determined following the method of Anjaneyulu *et al.* (1982).

$$\text{Maize Equivalent Yield (MEY)} = Y_m + \frac{Y_i P_i}{P_m}$$

Where, Y_m = Yield of maize (t ha⁻¹)

Y_i = Yield of intercrop vegetable (t ha⁻¹)

P_i = Price of intercrop vegetables (Tk ha⁻¹)

P_m = Price of maize (Tk ha⁻¹)

Land equivalent ratio (LER). LER is the relative area of the sole crop that would be required to produce the equivalent yield achieved by intercropping. It is the summation of the ratio of yield of intercrop to the yield of the sole crop. It was calculated as follows

$$LER = LER^M + LER^L = (Y^{ML}/Y^{MM} + Y^{LM}/Y^{LL})$$

Where LER^M and LER^L are the partial LER of maize and intercrops, respectively. Y^{ML} = Yield of first intercrop, Y^{LM} = Yield of second intercrop, Y^{MM} = Yield of first sole crop, Y^{LL} = Yield of second sole crop

Results and discussion

As far as various intercropping indices depicting economic feasibility of the system concerned, significantly highest maize equivalent yield was recorded in maize + cauliflower (1:1) intercropping (156.7 q/ha) which was at par with maize + garlic (1:3) (146.7 q/ha) followed by Maize + potato (1:1) (142.4 q/ha), maize + cabbage (1:1) (136.3 q/ha), maize + green pea (1:1) (123.3 q/ha), maize + spinach (1:3) (116.1 q/ha), maize + fenugreek (1:3) (114.0 q/ha) and maize + coriander (1:2) (98.3 q/ha). These result and in conformity with those on Karim *et al.* (1989) who obtained highest yield from pure stand of maize and potato than maize + potato in combination. Mishra (2014) revealed that the dry matter accumulation, yield attributes such as cob weight, grain rows/cob, grains/cob and 100-grain weight, and yield of maize increased significantly when it was intercropped with potato compared with sole cropping of maize and most of the intercropping combinations, however higher values of these were also associated with maize + pea intercropping systems.

The maize grain yield (78.9 q/ha) was significantly higher in sole maize but at par with Maize: Fenugreek (1:3) (76.7 q/ha), Maize: Potato (1:1) (76.4 q/ha), Maize: Green pea (1:1) (74.1) and Maize: Coriander (1:2) (74.1 q/ha) and Maize: Garlic (1:3) (73.4 q/ha) as compared to other treatments. The Reduction in maize yield under these intercropping systems might be due to more competition for sunlight, CO₂ and space. The result confirms the findings of Sinha *et al.* (1999); Patra *et al.* (2000); Bharati *et al.* (2007) and Mishra (2015)

Significantly highest land equivalent ratio was recorded in maize + coriander (1.76) which was at par with maize + cauliflower (1.57) and maize + cabbage (1.54) followed by maize + spinach (1.41), maize + garlic

Table 1. Pooled data of yield parameters and economics of rabi maize intercropping for year (2018-19 & 2019-20)

Treatment	Maize yield (q/ha)	Intercrop yield (q/ha)	Maize equivalent yield (q/ha)	Land equivalent ratio	Return over variable cost	B:C ratio
T ₁ - Maize: Potato (1:1)	76.4	187.1	142.4	1.39	1,11,226	1.85
T ₂ - Sole potato	0.0	229.6	81.1	1.28	15,940	1.13
T ₃ - Maize: Green pea (1:1)	74.1	41.9	123.3	1.32	1,47,002	3.27
T ₄ - Sole green pea	0.0	60.8	71.6	1.24	74,191	2.56
T ₅ - Maize: Fenugreek (1:3)	76.7	63.4	114.0	1.38	1,33,259	3.12
T ₆ - Sole Fenugreek	0.0	80.5	47.4	1.20	42,143	2.10
T ₇ - Maize: Spinach (1:3)	70.6	77.3	116.1	1.41	1,37,764	3.24
T ₈ - Sole spinach	0.0	91.1	53.6	1.00	54,290	2.47
T ₉ - Maize: Coriander (1:2)	74.1	44.2	98.3	1.76	1,10,685	2.80
T ₁₀ - Sole coriander	0.0	54.7	30.0	1.00	17,774	1.48
T ₁₁ - Maize: Cauliflower (1:1)	72.9	94.9	156.7	1.57	1,95,958	3.70
T ₁₂ - Sole Cauliflower	0.0	149.1	131.6	1.00	1,61,682	3.61
T ₁₃ - Maize: Cabbage (1:1)	72.5	120.4	136.3	1.54	1,66,229	3.46
T ₁₄ - Sole Cabbage	0.0	195.5	103.5	1.00	1,22,262	3.28
T ₁₅ - Maize: Garlic (1:3)	73.4	49.8	146.7	1.40	1,80,422	3.54
T ₁₆ - Sole Garlic	0.0	108.3	159.2	1.00	1,80,742	3.01
T ₁₇ - Sole Maize (Control)	78.9	0.0	78.9	1.00	90,810	2.99
CD at 5%	5.7	14.8	12.8	0.13	-	-
SE(m)±	2.1	5.39	4.75	0.05	-	-

(1.40), Maize + potato (1.39), maize + fenugreek (1.38) and maize + green pea (1.32) as comparison to sole maize and sole vegetable crops. Ali *et al.* (2015) also reported that intercropping with maize crop gave maximum equivalent yield as comparison to sole crop. Mishra (2014) also conforms the study that Intercropping system of maize + potato recorded the highest total monetary returns and monetary efficiency (Rs/ha/day), followed by maize + pea, maize + wheat, maize + linseed, maize + mustard and maize + toria. Maize + potato and maize + pea gave on economic advantage of 66% (monetary-equivalent ratio 1.66) and 14% (monetary-equivalent ratio 1.14). Maize intercropped with potato gave the highest relative value total a relative net return, followed by maize + pea combination. Higher maize-equivalent yield and market price of potato and pea in these intercropping systems enhanced the relative value total by 176 and 85% with the highest values of relative net returns of 1.91 and 1.72 in order respectively.

The data postulated that maize + cauliflower (1:1) gave significantly higher gross monetary returns (Rs. 195958 ha⁻¹ and 3.70) followed by maize + garlic (Rs. 180422 and 3.54), maize + cabbage (Rs. 166229 and 3.46), Maize:

Green pea (Rs. 147002 and 3.27), maize + spinach (Rs. 137764 and 3.24), Maize + fenugreek (Rs. 133259 and 3.12), Maize: Potato (1:1) (Rs. 111226 and 1.85) gave significantly highest net monetary returns than rest of treatments. Similar trend was reported by Mishra *et al.* (2001) and Pawar *et al.* (2011). Many researchers also documented higher gross margin or net return in intercropping system than sole crop. Hossain *et al.* (2015); Razzaque *et al.* (2007); Alom *et al.* (2008); Bhuiyan *et al.* (2013) and Farhad *et al.* (2014). Uddin *et al.* (2009) also documented that all the Maize-vegetables intercropping system showed higher B:C than sole maize, which also strongly supports the above findings.

Conclusion

From the above result showed that maize intercropping Maize: cauliflower by maize + spinach, maize + garlic, maize + potato, maize + cabbage maize + coriander, maize + green pea and maize + fenugreek gave maximum maize equivalent yield land equivalent ratio, gross margin or net return as compared to sole crop and also have less incidence of insect and pest.

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