Himachal Journal of Agricultural Research 35 (2):154-157, 2009

Effect of maize leaf defoliation on production and economics of maize + legume intercropping systems

Ranbir Singh Rana, R. Prasad and S. S. Rana
Department of Agronomy
CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur-176 062, India.

Abstract

The field experiment was conducted in the Department of Agronomy, CSK HPKV, Palampur during *Kharif* 1998 and 1999 to assess the effect of maize leaf defoliation on yield of maize and legume component in pure stand of maize and maize + legume intercropping systems. The study revealed that yield contributing characters viz. number of cobs per plant, length of cob, 1000-grain weight and maize grain yield were not affected due to leaf defoliation but stover yield observed significantly more due to removal of maize green leaves after complete tasselling and silking stage. The legumes component yield in maize +legume intercropping systems increased due to leaf defoliation by 4.8 per cent in soybean (*Glycine max*), 26.9 per cent in mash (*Vigna mungo*) and 40.7 per cent in kulthi (*Dolichus biflorus*) compared to no defoliation. Maize grain equivalent yield, stover equivalent yield and net returns were significantly more to the tune of 149 kg/ha, 963 kg/ha and Rs. 1325, respectively in maize + legume intercropping systems where maize leaf defoliation was practiced compared to no leaf defoliation intercropping treatments. The land equivalent ratio was also higher by 4 per cent under the defoliation treatments. Therefore, it is concluded that stripping of lower leaves of maize plant except one below cob after complete tasselling and silking stage has high agronomic feasibility and economic viability to get higher maize grain, stover yield and net returns under mid-hill sub humid conditions of Himachal Pradesh.

Key words: Maize leaf defoliation, maize and legume intercropping.

Introduction

Among food grain crops, in terms of production and acreage, maize occupies first position globally followed by rice and wheat (Chauhan *et al.*, 2007). Maize has always been second priority crop in Asia after rice. In India it ranks fifth in area and third in production with 2.4 tonne per hectare productivity whereas in Himachal Pradesh its productivity is 2873 kg per hectare (Anonymous 2009). Maize is known for its versatile nature and tremendous genetic variability enabling it to grow successfully throughout the world covering the lowland tropical, subtropical and temperate agro climatic conditions. Maize is one of the major *Kharif* crop of Himachal Pradesh and has the highest yield potential ranking second in the country. Maize being grown at wider spacing provides an opportunity of accommodating other short durations like pulses or oilseeds crops for additional benefits. Intercropping of legumes with maize has high agronomic feasibility and profitability in mid hill conditions (Rana *et al.*, 2001). In maize the number of leaves per plant may be more than a dozen causing mutual shading effect and thus making lower leaves comparatively parasitic. Moreover, the lower leaves of maize start senescence after complete tasselling and dry by the time crop matures. It is a proven fact that maize defoliation before tasselling delayed maturity and after tasselling hastens maturity. Majority of hilly areas farmers are raising marginally both crops and livestock component for their livelihood. The land being scarce resource reflects in fodder scarcity in general. To study whether some of the lower maize leaves can be removed without reducing the yield of maize providing the additional benefit, the experiment was conducted to assess the effect of maize leaf defoliation on yield of maize +legume intercropping systems.

Material and Methods

The field experiment was conducted under sub-humid and sub temperate conditions at the research farm of Department of Agronomy, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur during *Kharif* 1998 and 1999. The soil of the experimental site was silty clay loam in texture and acidic in reactions. It was rated as medium in N (285 kg/ha), P (16.4 kg/ha), K (262 kg/ha) and organic carbon (0.92%). The total rainfall during crop season was 1585.4 and 1907.9 mm in 1998 and 1999 respectively. The field experiment was laid out in randomized block design with eleven treatments comprising pure maize (*Zea mays* L. hybrid 3438) with and without leaf defoliation and three intercrops viz. soybean (*Glycine max* var. Palam Soya), mash (*Vigna*

mungo, var. T-9) and kulthi (*Dolichus biflorus* var. HPC-4) in maize with leaf and without leaf defoliation. The legumes were sown at the time of maize sowing in between the maize rows followed additive series of row arrangement. There were five rows in intercropping and nine rows in pure stand of legumes whereas there were six rows of maize in both pure maize and in intercropping systems. The recommended dose of N, P_2O_5 and K_2O for maize (120:60:40) and legumes soybean (20:80:40), mash (20:60:40) and kulthi (20:40) were applied. Full doses of phosphorus, potassium and one third nitrogen dose was applied in maize at the time of sowing and remaining two doses of nitrogen were applied at knee high and tasselling stages. Among legume crops, the whole N, P and K were applied at the time of sowing both in sole and intercropping. In intercropping treatments fertilizers for legumes were applied according to the plant population.

The practice of leaf defoliation was done in pure as well as in intercropped maize by removing the lower leaves except one below the cob after complete tasselling and silking stage within 2-3 days. The green leaves removed were used as green fodder. The economics of treatments were worked out based on prevailing market prices. The cost of green forage yield of maize leaves was included in net returns. The land equivalent ratio (LER) was also calculated on the basis of sole maize yield without leaf defoliation (i.e. recommended practice) using following formula:
LER = $(Ya/Sa) + (Y_b/S_b)$ where Y_a & Y_b are the yield of individual intercrops in intercropping system, S_a and S_b are yields of sole crop. The crops were grown with all package of practices recommended for the region.

Results and Discussion

Yield attributes of maize

The yield attributes like number of cobs per plant, length of cob and 1000-grain weight were not affected due to defoliation of leaves in pure and intercropping of grain legumes in maize (Table 1). The numbers of grains were significantly affected due to defoliation of maize leaves and legume intercropping. Sole maize with and without leaf defoliations had no significant difference. The practice of intercropping gave more number of grains per cob than their respective sole stands. In one of the studies conducted at Indian Agricultural Research Institute New Delhi revealed that hybrid (CM 119 XCM 120) produced more grains/ m^2 compared to maize parents CM 119 and CM 120, where 0,33,66 or 100 percent leaf defoliation were imposed (Khanna and Maheswari, 1998).

Maize yield

Significantly higher maize grain yield by 9 percent was recorded in maize + soybean with and without leaf defoliation intercropping systems compared to sole maize without leaf defoliation (Table 2). The other intercropping systems did not reveal significant difference in maize yield. However, there were not significant differences in yield between maize intercropping systems and sole maize with leaf defoliation. The sole maize with or without leaf defoliation did not produce any significant difference in yield during both the years. The grain yields were higher by 7.9 per cent in 1998 and 4.6 per cent in 1999 in maize with leaf defoliation. Stover yield was significantly more in sole maize with leaf defoliation as compared to sole maize without defoliation. Similarly, among intercropping systems, maize with leaf defoliation gave significantly higher stover yield compared to without defoliation of leaves. This difference was 4-5-q/ha additional stover yield obtained as a result of the leaf removal after tasselling which is part of stover yield. The additional stover was obtained as in the leaf defoliation treatments green leaves were stripped whereas in without leaf defoliation treatments leaves below cobs after tasselling died and become residues in the field. Sood and Singh (1979) also reported that maize yield was not significantly affected when nine or more leaves per plant were maintained after removal of 4-5 leaves of maize in maize + soybean intercropping systems. Emam and Seghatoleslami (1999) from their study conducted in Iran also reported that removal of tassel and all leaves above cob except the nearest leaf to the cob at 10 days after silks completely emerged had no effect on grain yield. Zewdu (2003) concluded that 50 percent leaf defoliation of maize did not affect grain and stover yield components and yield of under sown legume crops.

Intercrop yields

The leaf defoliation in maize caused increase in grain yield of intercrops viz., mash, kulthi and soybean. Sole crop of legumes recorded significantly higher grain yield per hectare compared to intercropped legumes because there was 55 per cent less plant population (5 rows) in maize + legume intercropping systems compared to their respective pure stands. Amongst intercropping systems, grain yield of legumes were 4.8 per cent higher in soybean, 26.9 per cent in

Table 1. Effect of maize +legume intercropping systems and maize leaf defoliation on yield attributes of maize

Treatment	Number of cobs per plant		Length of cob (cm)		Number of grains per cob		1000-grain weight (g)	
	1998	1999	1998	1999	1998	1999	1998	1999
Sole maize	1.22	1.24	15.10	15.00	374	377	264.0	260.0
Sole maize (LD)	1.30	1.32	16.42	16.20	380	383	267.5	264.5
Maize + mash	1.34	1.41	15.67	15.10	408	410	264.5	266.5
Maize + kulthi	1.31	1.36	16.10	16.40	401	406	268.4	268.2
Maize + soybean	1.42	1.38	17.27	16.80	404	408	266.7	265.4
Maize (LD) + mash	1.38	1.37	17.27	15.80	403	407	268.0	269.4
Maize (LD) + kulthi	1.35	1.39	16.67	15.00	399	402	264.2	265.4
Maize (LD) + soybean	1.40	1.33	17.63	15.90	402	404	265.1	267.1
CD (P=0.05)	NS	NS	NS	NS	16.3	18.5	NS	NS

LD - Leaf defoliation

Table 2. Influence of maize +legume intercropping systems and maize leaf defoliation on grain and straw yields of maize and legumes

Treatment	Maize grain yield (q /ha)		Maize Stover yield (q/ha)		Grain yield of intercrop (q/ha)		Stover yield of legume intercrop (q/ha)	
	1998	1999	1998	1999	1998	1999	1998	1999
Sole maize	32.80	32.95	65.30	66.40	-	-	-	-
Sole maize (LD)	35.40	34.47	75.27 (70.67)	75.9 (71.10)	-	-	-	-
Sole mash	-	-	-	-	6.80	6.56	16.56	17.30
Sole kulthi	-	-	-	-	4.47	3.92	10.75	12.40
Sole soybean	-	-	-	-	12.70	11.42	21.35	22.00
Maize + mash	34.40	34.90	68.10	67.90	1.95	1.91	3.34	3.20
Maize + kulthi	35.00	33.20	70.40	67.50	1.24	1.12	2.20	2.70
Maize + soybean	36.20	35.20	74.20	72.50	4.80	4.71	7.90	8.35
Maize (LD) + mash	35.80	34.10	72.35 (68.20)	71.20 (67.20)	2.41	2.49	4.45	4.58
Maize (LD) + kulthi	35.10	34.20	76.15 (71.10)	73.35 (68.70)	1.88	1.43	3.71	3.21
Maize (LD) + soybean	36.60	35.10	77.37 (72.80)	81.63 (76.10)	4.96	5.02	9.46	10.94
CD (P=0.05)	2.65	2.20	4.62	4.36	0.48	0.57	1.32	1.76

Values in parentheses are stover yield after removal of leaves; LD - Leaf defoliation

mash and 40.7 per cent in kulthi in maize with leaf defoliation compared to no defoliation during both the years (Table 2). Similar trend was observed in straw yield of legumes. Amongst intercropping systems, maize with leaf defoliation gave 38.2 per cent in mash, 41.2 per cent in kulthi and 25.2 per cent in soybean higher straw yield of legumes compared to maize without leaf defoliation intercropping systems. The above findings are in conformity with the results of Sood and Singh (1979) who also reported 45.5 per cent higher grain yield of legume when intercropped with maize and maintaining nine leaves per /plant under Kullu valley of Himachal Pradesh. Subedi (1996) also reported that removal of leaves below and above the cob or by topping 30 days after 50 percent silking, had no effect on either maize yield or on that of relay cropped finger millet transplanted 45 days after maize sowing. Helima and Chauhan (2003) reported that mean dry matter yield of under sown forage legumes increased with increasing leaf defoliation of maize regardless of crop growth stage.

Yield potentials and economics

Maize grain equivalent yield was significantly affected due to intercropping of legumes and maize leaf defoliation (Table 3). Intercropping of legumes with maize proved

significantly better than pure stand of either maize or legume. Within intercropping system maize with leaf defoliation intercropping systems gave 5-9 per cent higher maize grain equivalent yield compared to maize without leaf defoliation intercropping systems. The maize Stover equivalent yield in leaf defoliation treatments were significantly higher compared to no defoliation. This is because of the fact that maize leaf defoliation gave 4-5 q/ha additional dry fodder yield of maize. Also the straw yield of legumes grown with maize plus leaf defoliation gave significantly higher yields. The land equivalent ratio did not differ significantly within intercropping system in maize with and without leaf defoliation (Table 3). There was 35-51 per cent added advantage in land equivalent ratio due to intercropping than pure cropping of maize. Higher net returns of Rs. 1016 were obtained in maize+ legume intercropping systems compared to sole stands of maize. Amongst intercropping systems, maize +soybean with and without leaf defoliation gave the higher net returns, however the values were higher in leaf removal treatments compared to no leaf removal treatment.

Table 3. Effect of maize + legume intercropping and maize leaf defoliation on yield potentials and economics (Pooled over two years)

Treatments	Maize equivalent grain yield (q/ha)	Maize Stover equivalent grain yield (q/ha)	Land equivalent ratio	Cost of cultivation (Rs./ha)	Net Returns (Rs./ha)	Gross Returns (Rs./ha)
Sole maize	32.88	65.86	1.0	9733	11595	21328
Sole maize (LD)	34.94	78.24	1.06	10377	13103	23480
Sole mash	29.10	40.65	-	7790	9283	17069
Sole kulthi	14.27	23.15	-	7390	1180	8574
Sole soybean	32.16	43.40	-	10740	8358	19098
Maize + mash	41.10	75.35	1.25	13700	12450	26150
Maize + kulthi	39.10	73.85	1.19	14610	10463	25075
Maize + soybean	47.10	89.75	1.42	14400	15803	32207
Maize (LD) + mash	43.75	84.68	1.33	14160	14034	28198
Maize (LD) + kulthi	40.25	84.10	1.22	14780	11958	26750
Maize (LD) + soybean	47.86	99.19	1.46	14680	16695	31380
CD (P=0.05)	2.72	6.61	0.16		1190.0	

LD - Leaf defoliation, Prices = Maize grain Rs. 4.50/kg, Soybean grain=Rs 12.00/kg, Mash =Rs 17.00/kg, Kulthi Grain=Rs 16.0 /kg, Maize Stover=Rs 100/quintal and Legume straw=Rs 150 /quintal

References

Anonymous 2009. 52nd Annual Progress Report All India Coordinated Research Project, page 15, Directorate of Maize Research, Indian Council Agricultural Research, New Delhi.

Chauhan SK, Sharma RK, Sharma HR and Sharma BK 2007. Emerging patterns of maize production, demands and processing, Research Report No 35, Department of Agricultural Economics, CSK HPKV, Palampur, H.P., pp 35.

Emam Y and Seghatoleslami MJ 1999. The effect of defoliation on the pattern of dry matter accumulation and grain yield in hybrid maize (*Zea mays* L.). Iranian J. Agric. Sci. **30** (2):215-23.

Helima Hassen and Chauhan SS 2003. Effect of rate of maize leaf defoliation at various growth stages on grain and stover yield components of maize and under sown forage production. Indian J. Agric. Res. **37** (2): 137-39.

Khanna Chopra R and Maheswari M 1998. Effect of altering source availability on expression of sink capacity in a maize hybrid and its parents. European J. Agron. **9** (2&3): 101-07.

Rana RS, Singh B and Negi SC 2001. Management of maize/legume intercropping under mid hill sub humid conditions. Indian J. Agric. Res. **35** (2): 100-03.

Sood BR and Singh CM 1979. Effect of leaf defoliation on yield of maize and intercropped soybean. Him. J. Agric. Res. **7**(1&2): 98-100.

Subedi KD 1996. Effect of leaf stripping, detaselling and topping of maize on the yield of maize and relay intercropped finger millet. Exp. Agri. **32** (1): 57-61.

Zewdu T 2003.Effect of defoliation and intercropping with forage legumes on maize yield and forage production. Tropical Sci. (U.K.) **43** (4):204-07.