Indian Journal of Agronomy **45** (3) : 515–519 (September 2000)

Growth and yield of winter maize (*Zea mays*) as influenced by intercrops and nitrogen application

D.P. SINGH, N.S. RANA[1] AND R.P. SINGH[2]

Amar Singh College, Chaudhary Charan Singh University, Lakhaoti, Uttar Pradesh 245 407

Received: December 1998

ABSTRACT

A study was undertaken by introducing lentil (*Lens culinaris* Medikus) and vegetable pea (*Pisum sativum* L.) as intercrops in winter maize (*Zea mays* L.) fertilized with 0, 50, 100, 150 and 200 kg N/ha during winter season of 1992–93 and 1993–94, to study the growth and yield behaviour of maize. Inclusion of legumes (pea or lentil) as intercrops increased the dry-matter accumulation of maize + pea cropping system. The yield attributes, viz. length and girth of cob, number and weight of grains/cob, cobs/plant and 1,000-grain weight, were also increased by intercropping of legumes. Further pea had an edge over lentil. Respective mean maize grain yields were 46.4, 54.3 and 53.5 q/ha when maize was grown as sole and intercropped with pea or lentil. Maize responded to N application up to 200 kg/ha in sole stand and up to 150 kg N/ha when intercropped with either of legumes. Mean maize equivalents were 47.3, 115.3 and 67.2 q/ha under maize, maize + pea and maize + lentil intercropping respectively.

Key words : Winter maize, Intercropping, Grain yield, Maize equivalent

Temporal and spatial intensification of cropping is the need of the day to keep the pace between foodgrain production and the burgeoning population in a densely populated country like India. Though intercropping is an age-old paractice it has attracted worldwide attention owing to yield advantages (Willey, 1979) if the crops selected are compatable and grown with scientific production technology. Introduction of thermo-insensitive hybrids of maize has made its cultivation possible during winter (*rabi*) season where it takes longer time and offers an opportunity for intercropping. Escalating prices of the fertilizer inputs are, however, becoming bottleneck in sustaining growth of foodgrain production. Legumes are

Present address : [1,2]Department of Agronomy, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, Uttaranchal 263 145

common components of intercropping system and it has often been assumed that they may provide some N economy. Hence this study was undertaken to economize cultivation of winter maize.

METERIALS AND METHODS

The field experiment was conducted at Lakhaoti during the winter season of 1992–93 and sandy-loam soil, low in organic carbon, medium in available P and K, with pH 7.8. Treatments consisting of combinations (15) of 3 cropping systems, viz. maize, maize + pea and maize + lentil, and 5 N levels (0, 50, 100, 150 and 200 kg/ha) applied to maize were tested in randomized block design and replicated thrice. Maize hybrid 'PSCL 507' was spaced at 60 cm row spacing and 2 rows of either lentil ('PL 639') or pea ('Arkel') were taken between 2 rows of maize, keeping 30 cm intra-specific and 15 cm inter-specific distances. The base crop was sown on 24 October and 5 November and harested on 6 May and 13 May during 1992–93 and 1993–94. All the crops were grown with recommended practices. Pea was taken for vegetable purpose and picked thrice. A uniform dose of 80 kg P_2O_5 and 60 kg K_2O/ha was applied to maize as basal. Nitrogen was given in 3 splits (one-fourth basal, half at knee height and one-fourth at tasseling stage). No additional fertilizer was applied to intecrops. Rainfall received during crop period of 1992–93 and 1993–94 was 159 and 99.5 mm respectively. Market prices prevailing during crop period were used for computing maize equivalent.

RESULTS AND DISCUSSION

Yield attributes of maize

Intercropping of legumes led to improvement in yield attributes of maize, viz. cob length, cob girth, number and grain weight, cobs/plant and 1,000-grain weight (Table 1), though the improvement was significant only for grain weight/cob. In general, the highest values were recorded when pea was intercropped with maize. The improvement in yield attributes might have occurred owing to better establishment of plants and more photosynthetically active leaf area. Advantage of pea over lentil might have been owing to early harvest of pea before peak growth period of maize and subsequent release of nitrogen from root nodules. The results confirm the findings of Veenugopal and Shivashankar (1991) and Kumar and Singh (1992).

All the yield attributes showed an increasing trend with increasing levels of N up to 200 kg/ha, though the increase beyond 150 kg N/ha was not significant. It might have been owing to better utilization of resources under improved N supply, as it is an integral part of proteins the building blocks of plant.

Maize grain yield

In accordance to growth and yield attributes, high attributes, high yields were associated with legume-based intercropping systems as compared to sole maize (Table 2). An intercropping of pea and lentil increased the mean grain yield by 16.8 and 15.2% over sole crop.

An increase in grain yield beyond 150 kg N/ha was 11.1% in sole stand against

Table 1. Effect of cropping systems and nitrogen application on yield attributes of maize

Treatment	Cob length (cm)		Cob girth (cm)		Grains/ cob		Grain weight/ cob (g)		Cobs/ plant		1,000-grain weight (g)	
	1992–93	1992–93	1992–93	1992–93	1992–93	1992–93	1992–93	1993–94	1992–93	1992–93	1992–93	1992–93
Cropping system												
Maize	14.6	14.5	11.7	11.3	275	262	55.7	51.6	1.00	0.97	224	216
Maize + pea	15.6	15.5	12.5	11.6	294	283	61.5	56.9	1.13	1.04	231	220
Maize + lentil	15.5	15.2	12.4	11.5	295	283	60.9	56.5	1.12	1.04	230	219
CD (P=0.05)	NS	NS	NS	NS	NS	NS	4.0	3.1	NS	NS	NS	NS
N (kg/ha)												
0	12.2	11.8	10.8	9.9	229	221	44.5	45.0	0.80	0.80	214	205
50	14.5	14.3	11.8	11.0	260	247	55.0	49.3	1.02	0.94	232	215
100	15.6	15.9	12.5	11.7	293	280	62.4	53.3	1.20	1.00	232	220
150	16.8	16.6	13.0	12.3	322	310	66.1	61.4	1.22	1.13	232	225
200	17.1	16.7	12.9	12.3	335	321	68.7	63.8	1.25	1.13	230	226
CD (P = 0.05)	1.7	1.2	0.9	1.0	37	27	5.1	4.0	0.18	0.15	17	18

* Grain yield for maize and lentil and green pod yield for pea
Figures in parentheses are of lentil and those outside are of pea
Commodity prices (Rs/q) : Maize, 350; lentil, 620; pea, 205

2.6 and 3.8% with pea and lentil intercropping, respectively, indicating N economy by intercropping of legumes (Table 3). Such differential behaviour might have been due to augmentation of N supply by the legumes grown in association of maize. Hamel and Smith (1992) were also of the opinion that the N fixed by soybean was transferred to sorghum and maize when grown in association.

Intercrops yield

Increasing levels of N applied to maize did not show any significant effect on pea pod yield (Table 2). It might have been due to splitting of N, as a significant amount was top-dressed after pea harvest. Contrary to it, lentil yield exhibited declining trend with increasing N level, as it continued for a longer period with maize and suffered due to shading effect. Further, excess of vegetative growth particularly in terms of plant height was observed in lentil.

Maize-equivalent yield (MEY)

Maize + pea gave highest MEY, being 144 and 71.5% more than sole maize and maize + lentil respectively (Table 2). Superiority of pea to lentil, as intercrop, might have been owing to its escape from shading effect because of early harvest. Contrary to it, lentil suffered severely in its yield-formation phase due to shading effect of maize. Such yield advantages might have been owing to better utilization of solar radiation by combined crop canopy

Table 2. Effect of cropping systems and nitrogen application on yield of component crops and maize equivalent

Treatment	* Yield (q/ha)					
	1992–93			1993–94		
	Maize	Intercrop	Maize-equivalent yield	Maize	Intercrop	Maize-equivalent yield
Cropping system						
Maize	49.6		50.1	43.3		4.5
Maize + pea	58.3	10.8.1	121.9	50.2	100.2	108.6
Maize + lentil	58.6	7.9	71.6	49.4	7.5	62.8
CD (P = 0.05)	4.5		6.8	4.0		5.3
N (kg/ha)						
0	30.2	112.9 (9.5)	58.0	30.7	99.2 (10.2)	56.0
50	48.2	108.5 (8.9)	74.7	40.1	104.1 (7.6)	64.9
100	60.6	109.6 (9.0)	87.4	50.1	98.8 (7.3)	73.6
150	67.6	103.6 (6.2)	91.5	57.1	103.1 (6.5)	81.3
200	70.1	106.0 (6.0)	94.4	62.0	95.6)5.9)	84.1
CD (P = 0.05)	5.8	NS (1.1)	8.8	5.1	NS (1.1)	6.8

* Grain yield for maize and lentil and green pod yield for pea; Figures in parentheses are of lentil and outside the parentheses are of pea; commodity prices (Rs/q) : maize, 350; lentil, 620; pea, 205

Table 3. Effect of nitrogen application on maize grain yield (q/ha) under different cropping systems

Cropping system	Nitrogen (kg/ha)				
	0	50	100	150	200
			1992-93		
Maize	24.9	38.2	53.3	63.9	70.4
Maize + pea	33.3	53.4	64.7	69.9	70.0
Maize + lentil	32.5	53.0	63.7	69.0	69.9
CD (P=0.05%)	C × S = 9.0				
			1993–94		
Maize	26.2	34.6	45.2	54.9	61.6
Maize + pea	32.5	43.3	51.6	59.2	62.4
Maize + lentil	33.4	42.5	51.3	58.0	62.0
CD (P + 0.05%)	C × S = 8.8				

CS, interaction between cropping system and nitrogen levels

and of water and nutrients by combined root system (Snaydon and Hams, 1979). Maize-equivalent yield exhibited an increasing trend with increasing levels of N up to 200 kg/ha, though the increase was significant only up to 150 kg/ha.

REFERENCES

Willey, R.W. 1979. Intercropping : its importance and research needs. Part I. Competition and yield advantages. *Field Crops Abstracts* **32** : 1–10.

Hamel, C. and Smith, D.L. 1992. Mycorrhizal mediated ^{15}N transfer from soybean to corn in field grown intercrops: Effect of component spatial relationship. *Soil Biology and Biochemistry* **24** : 499–501.

Kumar, S. and Singh, R.P. 1992. Cob characteristics and soybean yield in maize-legume intercropping system. *Haryana Journal of Agronomy* **8** (1) : 38–43.

Snaydon, R.W. and Hams, P.M. 1979. Interaction below ground. The use of nutrient and water. (In) *Proceedings of the International Workshop on Intercropping,* held during 10–13 January at ICRISAT, Hyderabad, pp. 158–201.

Veenugopal, N and Shivashankar, K. 1991. Influence of maize (*Zea mays* L.) crop residue and nitrogen on the productivity and economics of maize + soybean (*Glycine max*) intercropping under paired row system of planting. *Indian Journal of Agronomy* **36** (4) : 502–507.