Madras Agric. J., 99 (7-9): 530-532, September 2012
https://doi.org/10.29321/MAJ.10.100132

Productivity and Profitability of Maize Based Intercropping Systems

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To find out the most compatible legume intercrop in maize, field experiments were conducted at G. B. Pant University of Agriculture and Technology, Pantnagar during 2007 and 2008 with six treatments viz., sole maize, maize + urdbean (2:2), maize + mungbean (2:2), maize + cowpea (2:2), maize + groundnut (2:2) and maize + soybean (2:2) in randomized block design with three replications. Maize was sown in paired row system of 45/90 cm in all the treatments. Two lines of intercrops were sown in inter-space of 90 cm between two pair. Grain yield of maize in sole crop was significantly more than intercropped with urdbean, mungbean and soybean. Though, intercropping of legumes reduced the grain yield of maize, intercropping increased the maize equivalent yield than sole maize. Maize + groundnut system recorded significantly more maize equivalent yield and was economically more viable than other maize based intercropping systems.

Key words: Intercrop, legume, maize, paired row, yield.

Owing to high population pressure and less chance of increase in cultivated land, intercropping seems to be one of the options to increase food grain production and intensify land use as well as to meet the diversified need of farming communities from limited area. Intercropping offers to farmers the opportunity to engage nature's principles of diversity at their farm (Ghosh, 2004). Among cereals, maize being a widely spaced crop offers an opportunity for intercropping where legumes of short stature like urdbean, mungbean, cowpea, groundnut and soybean can be grown. Intercropping of legumes with maize helps not only in efficient utilization of recourses per unit area and time but also increases the income. The role of maize intercropping for producing extra crop and for keeping down weeds has been reported by Pandey *et al.* (1981). Multiple crops in a single field also reduce the amount of herbicides or fertilizers applied to that field at any time. Pest management benefits can also be realized from intercropping due to increased diversity. In maize + legume intercropping systems, both crop, maize and legumes have different peak demand for light, nutrients and water, therefore it facilitates optimum utilization of resources but indeterminate growth habit and low nitrogen requirement of legumes restrict top dressing of urea in maize at critical growth stages. Split application of nitrogen in maize affects legume intercrops adversely. Hence, suitable intercrop and spatial arrangement of main and intercrop must be considered when planning legume intercropping. In view of this, the present study was undertaken to find out the most compatible legume in maize based intercropping systems.

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Materials and Methods

Field experiments were conducted during *kharif* 2007 and 2008 at G. B. Pant University of Agriculture and Technology, Pantnagar. The soil was sandy loam in texture, neutral in reaction (P_H 7.3), medium in organic carbon (0.57 %), low in available nitrogen (223. 6 kg/ ha), medium in available phosphorus (19.9 kg/ ha) and potassium (147.8 kg/ ha).

The experiment consisted of six treatments viz., sole maize in paired row (45/90 cm), maize (45/90 cm) + urdbean (2:2), maize(45/90 cm) + mung bean (2:2), maize (45/90 cm)+ cowpea (2:2), maize (45/ 90 cm) + groundnut (2:2)and maize (45/90 cm) + soybean (2:2) was laid out in randomized block design with three replications.

Maize crop was sown in paired rows of 45/90 cm in all the treatments. Furrows at 45 cm distance were opened by tractor mounted furrow opener and every third furrow was closed manually. Thus space between two pair (i.e.90 cm) was used for sowing of intercrops and two rows at 30 cm were accommodated. The intra- spacing of 30 and 10 cm for maize and intercrops, respectively, was maintained after thinning. The maize variety 'Polo' (hybrid), urdbean 'Pant Urd -35', mungbean 'Pant Mung-4', cowpea 'PGCP-4', groundnut 'GG-2' and soybean 'PS-1347' were used. The main and intercrops were grown with their full agronomic practices. One third of N (40 kg/ha) and full P_2O_5 (60 kg/ha) and K_2O (40 kg/ha) were applied as basal.

Remaining N (80 kg/ha) was top dressed in two equal splits first at knee high and second at tasseling stage with care of urea application in pair rows of maize to avoid N fertilization in legume intercrops. Sources of nitrogen, phosphorus and potassium were urea, SSP and MOP, respectively. The crops were sown on 27th June and 26th June in 2007 and 2008 and harvested on 15th October 2007 and 16th October 2008, respectively. Intercrops were sown with maize but harvested prior to maize. For comparison between treatments, the yields of all intercrops were converted in to maize equivalent yield on price basis. Cost of cultivation was calculated by taking current market prices of inputs while gross returns were obtained by multiplying grain yield with minimum support price/market price. The B:C ratio was calculated by dividing the gross return by cost of cultivation.

Results and Discussion

Yield attributes

There was no significant variation in plant population of maize at harvest stage and this indicated that there was no interference of intercrops on establishment of maize crop. Yield attributes of maize viz., cob length, cob girth and 100- grain weight differed significantly owing to different intercrop combinations. However, during first year of experimentation, cob length and girth remained unaffected (Table 1). In the second year, only maize + mungbean system exhibited cobs of significantly lower length than sole maize crop. Intercropping of urdbean, mungbean and cowpea resulted in significant reduction in cob girth compared to sole maize. Lesser 100-grain weight was recorded in maize + urdbean system which was significantly lower than that of sole maize. Rest of the intercropping combinations were at par with sole maize with respect to 100- grain weight except mungbean in 2008. Trailing of urdbean and mungbean on maize plant might have resulted in poor development of cobs. These results confirm the findings of Pandey *et al*. (2003)

Table 1. Effect of maize based intercropping systems on plant stand, yield attributes, grain yield of maize and maize equivalent yield

Treatment	Plant stand /ha		100- grain weight (g)		Cob length (cm)		Cob girth (cm)		Grain yield (kg/ha)				Maize equivalent yield (kg/ ha)	
									Maize		Intercrop			
	2007	**2008**	**2007**	**2008**	**2007**	**2008**	**2007**	**2008**	**2007**	**2008**	**2007**	**2008**	**2007**	**2008**
Sole Maize (45/90 cm)	78395	56790	33.8	28.5	16.6	20.1	13.5	15.8	6990	4614	-	-	6990	4614
Maize + Urdbean(2:2)	79381	56790	27.5	26.2	14.9	18.9	12.3	14.5	4725	4012	630	492	6497	5361
Maize + Mungbean(2:2)	81790	57098	32.5	26.6	15.1	17.9	13.4	14.6	6296	3851	400	329	7425	4756
Maize + Cowpea(2:2)	77762	58333	31.3	27.5	14.8	18.6	12.9	15.2	6111	4135	772	601	8283	5640
Maize + Groundnut (2:2)	78703	56790	32.6	28.1	15.2	19.5	12.9	15.5	6698	4289	1296	965	10346	6705
Maize + Soybean(2:2)	79319	57098	31.1	27.7	14.6	19.4	12.9	15.3	5913	4182	972	740	7747	5435
CD (0.05)	NS	NS	3.4	1.4	NS	1.8	NS	0.6	926	985	-	-	947	1008

Yield

Differences in yield of maize crop between two years of experiment were mainly due to variation in plant population. More plant population of maize in year 2007 owing to better weather conditions resulted in high yield levels than year 2008. Intercrops influenced maize grain yield differently. All the intercropping combinations had lower maize grain yield than sole cropping. Maximum decline in maize grain yield was noted with urdbean (32.4 %) and mungbean (16.5 %) during both the years, respectively, while minimum was in maize + groundnut. Maximum grain yield was obtained in sole maize (6990 and 4614 kg/ha, respectively), which was significantly higher than maize + urdbean intercropping during both the years (Table 1). Maize + soybean in first year and maize + mungbean in second year also recorded significantly lower yield than sole maize. Vigorous growth of urdbean and mungbean might have resulted in adverse effect on maize yield by reducing yield attributes *viz.,* 100-grain weight, cob length and cob girth. Similar results were also reported by Mittal *et al.* (1985).

Table 2. Economics of maize based intercropping systems

Treatment	Cost of cultivation (Rs./ha)		Gross return (Rs./ha)		Net return (Rs./ha)		B:C ratio	
	2007	**2008**	**2007**	**2008**	**2007**	**2008**	**2007**	**2008**
Sole Maize (45/90 cm)	11626	10424	37750	28604	26120	18181	3.24	2.75
Maize + Urdbean(2:2)	11976	10774	35091	33240	23115	22466	2.93	3.09
Maize +Mungbean (2:2)	11976	10774	40078	29489	28102	18715	3.35	2.74
Maize + Cowpea(2:2)	12166	10964	44734	34987	32568	24023	3.67	3.19
Maize +Groundnut(2:2)	14026	12824	55868	41571	41842	28747	3.98	3.24
Maize +Soybean (2:2)	13426	12224	41828	33699	28402	21475	3.11	2.76

Maize equivalent yield was high in all the intercrop combinations mainly because of high price of legumes except in urdbean during first year. In comparison to sole maize significant increase in maize equivalent yield was observed only in groundnut and cowpea intercropping. Maize + groundnut system produced significantly the higher maize equivalent yield (103.46 and 67.05 q/ha) that was 48.0 and 45.3 per cent more than sole maize in both years, respectively. High maize equivalent yield with groundnut was due to more yield and high market price of groundnut. Among intercrops, grain yield was high in groundnut (1296 and 965 kg/ha) and low in mungbean (400 and 329 kg/ha) during both the years. Poor yields of urdbean and mungbean and low yield of maize in association with them resulted in lower maize equivalent yield than other intercropping systems. Gangwar and Kalra (1982) also observed increase in total grain yield over pure maize crop when grown with legumes.

Economics

Cost of cultivation in second year of experimentation was low due to less number of irrigation. Difference in cost of cultivation among treatments was because of variation in seed rate and seed price of intercrops. High maize equivalent yield of maize + groundnut intercropping made it more remunerative and economically more viable as it gave more gross return, net return and B:C ratio during both the years (Table2). These results are in the conformity with the findings of Padhi (2001).

Groundnut may be a viable and remunerative intercrop in maize based intercropping systems in *Tarai* region of Uttarakhand.

Acknowledgement

Authors are grateful to ICAR, AICRP on Maize for providing financial assistance for this study.

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Received: February 7, 2012; Accepted: May 17, 2012