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Production potential of maize (*Zea mays*) + potato (*Solanum tuberosum*) intercropping as influenced by fertilizer and potato genotypes

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ABSTRACT

An experiment was conducted during 1993–94 and 1994–95 on intercropping of potato (*Solanum tuberosum* L.) varieties with 'Devki' maize (*Zea mays* L.) to maximize the productivity of winter maize + potato-based intercropping system under various fertility levels. Maize intercropped with early potato ('Kufri Chandramukhi') was more compatible and advantageous than other potato varieties. Various growth and yield attributes of winter maize were superior under sole cropping, followed by winter maize + early potato. This combination recorded the highest maize-equivalent yield (178.96 q/ha) and yield advantage (163%). Among the fertility levels, recommended NPK dose to maize + 50% recommended NPK dose to potato proved more economic than rest of the fertility levels in maize + potato intercropping system.

Key words : Intercropping, Maize, Potato, Fertility, Maize-equivalent yield

Substantial advantage in yield from intercropping compared with sole cropping occurs from complementary effect of different crops or varieties on each other, making better use of resources when grown together (Willey, 1979). In Bihar plains, winter maize became more popular owing to high productivity. However, due to low temperature in December–January slow growth of maize takes place till mid-January. Besides, it is widely spaced crop and there is ample scope to grow short-duration intercrops in the interspaces. Intercropping of potato in winter maize is economically more viable than other intercrops, sole maize as well as sole potato (Prasad and Prasad, 1988). Since little information on potato cultivars and fertility levels is available on maize + potato intercropping system, an experiment was conducted to find out the most suitable potato variety as an intercrop with winter maize and their economic nutrient level for calcareous soils of north Bihar conditions.

MATERIALS AND METHODS

The experiment was conducted with 'Devki' maize at Tirhut College of Agricul-

ture Farm, Dholi (Muzaffarpur), Bihar, during winter seasons of 1993–94 and 1994–95. The soil was sandy loam, having pH 8.2, organic carbon 0.48%, available N 173.20 kg/ha, available P_2O_5 21.58 kg/ha and available K_2O 129.60 kg/ha. The treatment comprised 3 intercropping systems, viz. P_1, maize + early potato ('Chandramukhi'); P_2, maize + medium- duration potato ('Kufri Chamatkar'); and P_3, maize + late potato ('Rajendra Aaloo'); and 5 fertility levels, viz. F_0, recommended NPK dose of fertilizer to maize + no fertilizer for potato; F_1, recommended NPK dose of fertilizer to maize + 25% recommended NPK dose to potato; F_2, recommended NPK dose to maize + 50% recommended NPK dose to potato; F_3, recommended NPK dose to maize + 75% recommended NPK dose to potato and F_4 recommended NPK dose to maize + 100% recommended NPK dose to potato); and 4 monocropping, SM, sole maize; SP_1, sole early potato; SP_2, sole medium potato; and SP_3, sole late potato were also included. Thus 19 treatments were tested in randomized block design with 3 replications. Cut tubers having 2–3 eyes were sown in furrows opened by small type of wheel hoe, maintaining 60 cm × 20 cm spacing on 13 and 8 November 1993 and 1994 respectively. Now cut tubers earthen up by making the ridge of about 20

Table 1. Growth and yield attributes of winter maize as affected by different treatments (pooled data of 2 years)

Treatment	Plant height (cm)	LAI	Dry matter accumulation /plant (g)	Fertile plants (1,000/ha)	Cob length (cm)	Grains/ cob	1,000-grain weight (g)
Intercropping system							
P_1	142.7	3.1	174.7	59.8	17.3	379.3	204.0
P_2	132.5	3.1	161.2	59.5	16.8	364.5	202.2
P_3	129.0	2.9	152.2	58.5	16.5	342.5	199.3
CD (P = 0.05)	3.05	0.11	3.62	NS	0.26	10.21	NS
Fertility level							
F_0	112.0	1.8	131.0	53.6	15.2	301.0	190.8
F_1	124.6	2.4	150.3	57.1	16.2	341.0	197.8
F_2	134.5	3.2	165.7	60.5	17.1	365.8	203.0
F_3	146.5	3.8	178.2	61.8	17.5	395.7	207.8
F_4	155.8	4.0	188.3	62.7	17.9	407.2	208.6
CD (P = 0.05)	3.8	0.2	5.2	1.6	0.4	12.4	7.3
SM	149.0	4.2	194.0	63.9	17.9	398.4	218.4
Rest	134.7	3.1	162.7	59.1	16.8	362.1	201.8
CD (P = 0.05)	4.6	0.3	6.4	2.1	0.5	14.8	10.2

Details of treatments are given in text.

cm height at the same time. Maize in intercropped situations, was sown at bottom of the each potato ridge, maintaining 60 cm × 25 cm spacing, 10 days after potato planting. Sole maize was also sown on the same day on flat land, maintaining the distance of 60 cm × 25 cm. In this way, plant population of maize and potato under both the situations were kept uniform. Fertilizer were applied as per treatments using recommended dose of 120, 75 and 60 kg N, P_2O_5 and K_2O/ha for maize and 150, 60 and 100 kg N, P_2O_5 and K_2O/ha for potato. Half dose of N and full dose of P and K were applied basal prior to sowing in furrows opened just by the side and deeper than the seed furrow in all the situations as per treatment. The remaining N for the sole potato and intercrop was placed by the side of the crop rows after first irrigation, but in case of pure maize, it was top-dressed in 2 equal splits, one-fourth at knee-high stage and the rest at tasselling stage. Potato was harvested in middle of March (late) in both the years. Maize was harvested on 25 and 23 May 1994 and 1995 respectively. The yields of all the crops were recorded and maize-equivalent yield was worked out on the basis of prevailing market prices. In both the years of experimentation, meteorological parameters were more or less same and the crop seasons were normal.

RESULTS AND DISCUSSION

Growth attributes

The plant height, leaf-area index (LAI) and dry-matter accumulation in maize was the highest in sole crop of maize and all these characters reduced significantly when maize was intercropped with different potato varieties (Table 1). Among the potato varieties as intercrops, potato var. 'Kufri Chandramukhi' was less competitive than others. This might be due to shortest maturity period. Regarding fertility levels, all the growth parameters studied significantly increased with increasing fertility levels. This might be due to more cell elongation and carbohydrate production owing to cumulative effect of fertilizers under increasing trend of nutrients. The results are in agreement with those of Jat *et al.* (1992) and Sinha *et al.* (1999).

Yield attributes

Yield attributes of maize, viz. fertile plants (1,000/ha), cob length, grains/cob and seed index, were recorded and all these characters showed superiority when maize was grown as pure stand than in intercropping system. In intercropping systems, maize under P_1 showed superiority to others. Yield-attributing characters significantly increased with corresponding increase in fertilizer levels.

Table 2. Grains/cob as affected by P × F interaction (pooled data of 2 years)

Fertility	Cropping system			
	P_1	P_2	P_3	Mean
F_0	310.0	307.6	285.4	301.0
F_1	347.0	336.4	339.6	341.0
F_2	390.2	268.5	338.7	365.8
F_3	408.6	404.2	374.3	395.7
F_4	440.7	405.8	374.5	407.2
Mean	379.3	364.5	342.5	
CD (P = 0.05)				
P × F		17.65		

There was a significant increase in grains/cob due to rise in fertility levels in P_1 only. However, same trend was observed up to F_3 in case of P_2 and P_3 sequences. Considering crop sequences under same level of fertilizers, in most of the fertilizers

Table 3. Grain or tuber yield, yield recovery, maize-equivalent yield (MEY), land-equivalent ratio (LER) and benefit : cost ratio as influenced by treatments (pooled data of 2 years)

Treatment	Yield (q/ha)		Yield recovery (%)	MEY (q/ha)	LER	Benefit : cost ratio
	Maize grain	Potato tuber				
Intercropping system						
P_1	46.80	142.56	84.25 (78.90)	178.96	1.63	2.21
P_2	43.96	158.06	79.14 (82.78)	173.81	1.62	2.18
P_3	40.42	178.83	72.76 (84.25)	170.32	1.62	2.09
CD (P = 0.05)	2.32	13.19		NS	NS	NS
Fertility level						
F_0	30.95	142.25	55.75 (95.00)	145.96	1.30	1.91
F_1	38.48	154.02	69.27 (81.14)	164.21	1.53	2.08
F_2	45.06	163.02	81.11 (85.77)	182.23	1.67	2.21
F_3	50.83	170.13	91.50 (89.77)	190.02	1.80	2.27
F_4	53.30	172.16	95.54 (91.01)	194.23	1.85	2.25
CD (P = 0.05)	2.80	14.12		10.24	0.11	0.12
SM	55.56		100		100	
SP_1		179.72	100			
SP_2		191.40	100			
SP_3		199.72	100			
Sole intercropping				123.93	1.24	2.19
Rest	43.72	160.31		174.55	1.62	2.14
CD (P = 0.05)	3.84	20.17		7.62	0.18	NS

Details of treatments are given in text; NS, Not significant
Figures in parentheses indicate percentage recovery of sole cropping

levels P_1 and P_2 were similar and both showed superiority to P_3.

Yield and land-equivalent ratio

Significantly higher grain or tuber yield was recorded under sole cropping, irrespective of crops or varieties. In intercropping significantly higher maize yield was obtained in maize + early potato than maize + mid and late potato, which was 84.25% of sole crop. Maize-equivalent yield and land- equivalent ratio (LER) were higher, being 178.96 q/ha and 1.63, than sole maize. This indicates the higher biomass production resulting in more efficient utilization of land and available resources under intercropping system. However, MEY and LER did not differ significantly due to varieties. This might be due to similar compatibility of potato varieties when grown as an intercrop with winter maize. The results confirm the findings of Sinha *et al.* (1994). Among the fertilizer levels, application of F_2 level of nutrients was economically more sound specially yield point of view. However, in case of LER it showed superiority up to F_3 level of fertilizer application. This finding also supports that of Sinha *et al.* (1999).

Benefit : cost ratio

Winter maize + early potato intercropping gave the highest benefit : cost ratio compared to rest of the sequences and pure stand also; however, these differences were at par among themselves (Table 3). Among the nutrient levels, it significantly increased up to F_2 level of nutrients. This was in accordance with the law of diminishing return.

Thus, intercropping of winter maize with potato irrespective of its varieties with 50% recommended fertilizers dose of potato as additional to maize was found more productive and advantageous on a system basis in calcareous soils of north Bihar.

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