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EFFECT OF INTEGRATED NUTRIENT MANAGEMENT ON PRODUCTIVITY OF MAIZE WITH MUNGBEAN INTERCROPPING

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ABSTRACT
Maize is a unique crop having importance at global level. The integrated nutrient management composing of different sources of nutrient and management practices complementary to intercropping systems plays a vital role in maintaining the soil fertility, increase productivity and long term sustainability. Keeping these things in view, an experiment was conducted daring Kharif 2009 and 2010 at Research Farm of Amar Singh Post Graduate College, Lakhaoti, Bulandshahar (UP). The main objective of experiment was to known the effect of I N M on productivity of maize with inter cropped mungbean. The result of experiment showed growth, yield attributes, maize equivalent yield, Net return and B:C ratio were significantly higher in 5 t ha^{-1} vermicompost +75% recommended dose of N.P.K. (S_4) over other treatments. It gave grain yield (4.77t ha^{-1}), maize equivalent yield (6.06t ha^{-1}), Net return (Rs 26273 ha^{-1}) and B: C ratio (0.85) over other treatments. In case of cropping systems maize + mungbean recorded significantly higher value over sole maize. Maize + mungbean gave grain yield (3.97t ha^{-1}), maize equivalent yield (6.21t ha^{-1}), Net return (Rs 31558 ha^{-1}) and B: C ratio (1.14) fallowed by sole Maize 3.82, 3.82, 9720 and 0.36, respectively. The lowest value recorded under M_1 and S_1 treatment over other treatments.

KEY WORDS: Intercropping, Maize, Mungbean and Productivity.

INTRODUCTION
Maize is the third most important cereal crop in India after Wheat and Rice. It is occupied 8.67 million hectare with 21.60 m tons production at average production of 2492 kg ha^{-1} during 2011-12 (GOI, 2013).The demand of Maize in India is expected to touch 42 million tons by 2025 of which 20-21% will be used for human consumption, about 60% as poultry and live stock feed and remaining 12-13% for industrial raw material (Anonymous, 2010). In Uttar Pradesh Maize is cultivated in an area of 0.71 million hectares and production is 1.04 million tons with productivity of 14-65kg ha^{-1}. Maize behaves an exhaustive nature, resulting reduces the soil fertility under sole cropping. Intercropping of maize + mungbean will have significant effect on soil fertility and productivity (Dahmardeh *et al*., 2010). The integrated nutrient management comprising of different sources of nutrients and management practices complementary to the intercropping systems play a vital role in maintaining the soil fertility and long term productivity for sustainable production.

MATERIALS & METHODS
Field experiments were conducted at Agronomy Research Farm, Amar Singh Post Graduate College, Lakhooti, Bulandshahar, Uttar Pradesh during Kharif season of 2009 and 2010. The experiment was layout under split plot design with three replications. The statistical comparisons among treatments were worked out as standard error (SEm±) and critical difference (C.D.) at 0.05 Level of productivity (R.S. Chandel, 1998). Two cropping systems, sole maize (M_1) and maize + mungbean (M_2) were allotted in main plots while nine nutrient management practices, control (S_1), 75% recommended dose of N.P.K.(S_2), 100% recommended dose of N.P.K.(S_3), 5.0 tons vermicompost +75% recommended dose of N.P.K.(S_4), Azotobacter +75% N and recommended dose of P&K (S_5), P.S.B.+75% P & recommended dose of N & K (S_6), Azotobacter + P.S.B.+75% N.P. and recommended dose of K (S_7), Azotobacter + P.S.B.+5.0 tons vermicompost and 50% recommended of N.P.K. (S_8) and Azotobacter + P.S.B.+2.5 tons vermicompost with 50% recommended dose of N.P.K. (S_9) were allotted in sub plots. The experimental soil was sandy loam in texture, medium fertility with slightly alkaline in reaction. Cultivation practices were followed as per standard recommendation for each crop. Variety H.M-10 of maize and Pant mung- 5 of mungbean were used in experiment. Observations on growth, yield and quality were recorded at harvest or after harvest of crop. Economics of treatments was computed prevailing market price of products, while discussion of results done on pooled data basis.

RESULTS & DISCUSSION
Effect of cropping systems
Effect of cropping systems on growth and yield attributes parameters are presented in Table-1. Plant height and dry matter accumulation were recorded significantly higher in maize + mungbean cropping system over sole maize, while no. of cob $plant^{-1}$, cob length and grain rows cob^{-1} were found nonsignificant response to cropping systems. Plant height and dry matter $plant^{-1}$ under maize + mungbean showed higher (208.80 cm and 211.10 g) over sole maize (203.61cm and 205.79 g). Higher plant height

may be due to lead of intercropped competition, while dry matter accumulation due to beneficial effect of mungbean on maize in intercropping system. The results confirm the finding of Balyan *et al*. (2008).

TABLE 1: Growth and yield attributes of maize influenced by intercropping and nutrient management practices (Pooled data 2009 and 2010)

Treatments	Plant height (cm)	Dry Matter (g/plot)	No. of Cob/Plant	Cob Length (cm)	Grain rows/ Cob
Cropping systems: (M)					
M_1	203.61	134.70	1.03	23.06	12.22
M_2	208.80	138.13	1.01	23.80	12.70
SEm±	0.53	0.35	0.01	0.24	0.09
CD at 0.05%	3.20	2.12	NS	NS	NS
Nutrient managements practices: (S)					
S_1	193.00	127.08	0.90	18.25	11.00
S_2	196.20	129.66	0.97	20.42	11.83
S_3	207.51	137.27	0.98	22.73	11.83
S_4	213.44	141.20	1.15	27.93	14.00
S_5	211.24	139.74	1.10	26.75	13.10
S_6	208.35	137.83	0.98	22.68	12.50
S_7	209.41	138.53	1.05	25.08	12.50
S_8	208.87	138.17	1.02	24.88	12.33
S_9	207.42	137.22	0.98	23.13	13.00
SEm±	1.06	0.70	0.03	0.32	0.33
CD at 0.05%	3.05	2.02	0.08	0.93	0.95

TABLE 2: Yield and Quality parameters of maize influenced by cropping system and nutrient management practices: (Pooled data 2009 and 2010)

Treatments	Biological yield tons ha^{-1}	Grain yield tons ha^{-1}	Harvest index %	Protein %
Cropping systems: (M)				
M_1	9.29	3.82	38.71	8.28
M_2	9.74	3.97	39.36	8.38
SEm ±	0.05	0.02	0.17	0.02
CD at 0.05%	0.29	0.13	NS	NS
Nutrient managements practices: (S)				
S_1	7.76	2.85	31.37	7.30
S_2	8.69	3.38	34.44	8.01
S_3	9.56	3.85	40.13	8.41
S_4	10.56	4.77	43.51	8.92
S_5	10.10	4.32	41.25	8.72
S_6	9.31	3.77	39.71	8.34
S_7	9.98	4.17	40.81	8.46
S_8	10.22	4.18	40.82	8.42
S_9	9.46	3.79	39.29	8.41
SEm ±	0.18	0.03	0.43	0.06
CD at 0.05%	0.54	0.09	1.25	0.17

Table-2 presented the effect of cropping system on yield and quality parameters of maize. Biological and grain yield of maize were recorded significantly higher in maize + mungbean intercropping over sole maize, while harvest index and Protein % were found nonsignificant. Biological and grain yield of maize under maize + mungbean showed higher (9.74 and 3.97 t ha^{-1}) over sole maize (9.29 and 3.82 t ha^{-1}). Increase in biological and grain yield of maize under intercropping might be due to favorable micro-climate and biological nitrogen fixation process in mungbean. Similar results have observed by Moses *et al*., (2000). Maize equivalent yield, gross return, net return and B: C ratio was recorded significantly higher in maize + mungbean intercropping over sole maize. Under intercropping, maize equivalent yield (6.21t ha^{-1}), gross expenditure (Rs 27655 ha^{-1} and gross return (Rs.59213 ha^{-1}) were showed higher under maize + mungbean over sole maize (3.82, 26655 and 36375, respectively). Higher maize equivalent yield and gross return under intercropping might be due to addition of inter crop yield value while gross expenditure due to extra input addition. Net return and B: C ratio under inter cropping showed Rs.31558 $ha^{-1}$and 1.4, which is higher than sole maize Rs.9720 and 0.36. High net return and B: C ratio might be due to more yields and comparably less expenditures under maize + mungbean intercropping. Similar results

under intercropping have been observed by Hugar and Palled (2008).

Effect of nutrient management practices

Nutrient management practices showed significant effect on growth and yield attributes parameters of maize over control (Table-1). Plant height under control (S_1) recorded lowest (193.00cm) while S_4 was highest (213.44 cm). Plant height in S_4 was at par to S_5 and significantly higher to other treatments. Similar trend was recorded under dry matter accumulation per plant. S_4 showed 141.20g plant^{-1} which remain at par to treatments S_5 and significantly higher than other treatments. Increase in plant height and dry matter accumulation under nutrient management practices might be due to inclusion of organic sources of nutrient such as vermicompost, Azotobacter, P.S.B. with chemical fertilizers. Yield attributes parameters *viz.* no of cob plant^{-1}, cob length and grain row cob^{-1} were recorded 1.15, 27.93 and 14.00, respectively under S_4 which was too close to treatment S_5 (1.10, 26.75 and 13.10). It might be due to balance and integrated nutrient management results in all round development and yield parameters. Yield and quality parameters of maize significantly influence by nutrient management practices over control (Table-2). S_1 treatment recorded lowest biological yield (7.76 t ha^{-1}), grain yield (2.85 t ha^{-1}), harvest index (31.37%) and protein (7.30%) among the treatments. Treatment S_4 showed highest biological yield (10.56 t ha^{-1}), grain yield (4.77 t ha^{-1}), harvest index (43.51%) and protein (8.92%) remain at par to treatment S_5 (10.10, 4.32, 41.25 and 8.72, respectively) were significantly higher than other treatments. Since, maize is more exhaustive crop there is need of sufficient quantity of nutrients to sapling for its good growth and yield. Among the nutrient management practices, combine application of vermin-compost with other different sources were able to supply nutrients to meet its requirement for long time as well as quick requirement at various stages. Combine application of both organic & inorganic sources to take care of maize nutrition more effectively leading to better productivity. Biofertilizers too accelerate the availability of nutrients through solubilization or mobilization. Uses of organic sources in maize for increasing yield have also been reported by Sumanta kimdu (2009).

Maize equivalent yield and economics of maize significantly influenced by nutrient management practices (Table-3). Nutrient management practices under treatment S_4 were recorded highest value of maize equivalent yield (6.06 t ha^{-1}), gross expenditure (Rs 30886 ha^{-1}), gross return (Rs 57159 ha^{-1}), net return (Rs 26273 ha^{-1}) and 0.85 B:C ratio, followed by treatment S_5 (5.54, 30413, 56512, 26099 and 0.85, respectively). Treatment S_1 was recorded lowest value of maize equivalent yield (3.74 t ha^{-1}), gross expenditure (Rs 23600 ha^{-1}), gross return (Rs 36108 ha^{-1}), net return (Rs 12508 ha^{-1}) and 0.52 B:C ratio. It is significantly lower value over rest of the treatment. Application of nutrient combination of organic and inorganic sources under S_4 treatment induced better availability of nutrient to crop. Biofertilizer *viz*. Azotobacter, P.S.B. increased nutrient solubility and gain more growth and development of maize. Gross expenditure of S_4 increased due to high cost of vermicompost. Similar observations were recorded by Suroshe *et al*. (2009).

TABLE 3: Maize equivalent yield and economics of maize influenced by cropping systems and nutrient management practices: (Pooled data 2009 and 2010)

Treatments	Maize equivalent Yield tons ha^{-1}	Gross expenditure Rs/ha	Gross return Rs/ha	Net return Rs/ha	B:C ratio
Cropping systems: (M)					
M_1	3.82	26655	36375	9720	0.36
M_2	6.21	27655	59213	31558	1.14
SEm±	0.03	-	237	17	0.01
CD at 0.05%	0.17	-	1445	102	0.05
Nutrient managements practices: (S)					
S_1	3.74	23600	36108	12508	0.52
S_2	4.38	25886	41987	16101	0.61
S_3	4.97	26648	47412	20764	0.77
S_4	6.06	30886	57159	26273	0.85
S_5	5.54	30413	56512	26099	0.85
S_6	4.89	26475	46617	20142	0.75
S_7	5.32	28240	52616	24376	0.86
S_8	5.33	30374	50733	20359	0.66
S_9	4.92	27874	47000	19126	0.68
SEm±	0.03	-	283	348	0.01
CD at 0.05%	0.09	-	815	1002	0.03

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