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Effect of nutrient uptake and economics of maize–cowpea intercropping systems

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Abstract
The field experiment was conducted, during Late rabi season (Feb to May. 2018), to find out the suitable ratio combination of intercropping with maize for higher and sustainable production. The experiment was laid out in Randomized Block Design consists of seven treatments *viz.*, T_1 - Maize sole crop, T_2 - Cowpea sole crop, T_3 - Maize + Cowpea 1:1 row proportion, T_4 - Maize + Cowpea 3:1 row proportion, T_5 – Maize + Cowpea 4:1 row proportion, T_6 – Maize + Cowpea 2:2 row proportion, T_7 - Maize + Cowpea 3:2 row proportion with three replication. The seeds of maize variety "Kanchan 25" were sown with a spacing of sole maize 60×20 cm and intercrop maize 60×10 cm, with duration 75 - 80 days. The sole and intercrop, Cowpea local variety were sown with a spacing of 30×10 cm with duration of 55-60 days. The nutrient content, nutrient uptake and economics of maize and cowpea were favourably influenced by the treatment, Maize sole crop (T_1). The results clearly proved that Maize sole crop (T_1) might be a suitable practice for achieve higher maize nutrient content and uptake with due to precaution on the soil physical condition.

Keywords: maize and cowpea

Introduction
Maize (*Zea mays* L.) ranks the third position among the cereals after rice and wheat across the globe. Maize can grown throughout the year mainly its photothermo-insensitive characteristics with highest genetic yield potential than other cereals, is known as Queen of cereals or miracle crop and can also easily fit in intensive cropping.
Maize is therefore an emerging industrial crop. Maize occupies an important place in food production. Maize is a wonder crop, because it can be used at any stage of crop growth. Early stage as succulent green fodder, very early cob stage as baby corn, little later stage as green cob and at fully matured stage as maize grain. Because of this ability it is also called as "Contingent crop". Maize has the potential to supply large amounts of energy-rich forage for animal diets, and its fodder can safely be fed at all stages of growth without any danger of oxalic acid, prussic acid as in case of sorghum (Dahmardeh *et al*., 2009) [1].
Javanmard *et al.* (2009) [3], worked on intercropping of maize with different legumes, observed that dry matter yield and crude protein yield of forage were increased by all intercropping systems as compared with the maize monoculture. Dahmardeh *et al.* (2009) [1] concluded that intercropping of maize and cowpea resulted in more digestible dry matter and also crude protein content than maize sole cropping.
In this juncture, the practice of intercropping paved the way for introduction of more than one crop in the same piece of land as companion crop with the base crop of castor which would results in effective utilization of available resources *viz.*, land, moisture, solar radiation, fertilizers and pesticides etc., in addition to the additional monetary returns to the farming community. Influence, to achieve the above facts this investigation was programmed and executed.

Materials and Methods
The experiment was conducted in Randomized Block Design consists of seven treatments *viz.*, T_1 - Maize sole crop, T_2 - Cowpea sole crop, T_3 - Maize + Cowpea 1:1 row proportion, T_4 - Maize + Cowpea 3:1 row proportion, T_5 – Maize + Cowpea 4:1 row proportion, T_6 – Maize + Cowpea 2:2 row proportion, T_7 - Maize + Cowpea 3:2 row proportion with three replication. The seeds of maize variety "Kanchan 25" were sown with a spacing of sole maize 60×20 cm and intercrop maize 60×10 cm, with duration 70 - 80 days. The sole and intercrop, Cowpea local variety were sown with a spacing of 30×10 cm with duration of 55-60 days. The fertilizer was applied @100 kg N, 50 kg P_2O_5 and 50 kg K_2O to the main crop and intercrop of maize and 25:50: 25 kg ha^{-1} of N, P_2O_5 and K_2O was applied to the pulse intercrop plot. Half of the recommended nitrogen, entire dose of phosphorus and half dose of potassium were applied as basal after sowing. The remaining half dose of nitrogen and potassium were applied in two equal splits at 35 and 45 DAS.

Result and Discussion

Nutrient content (Table 1)

The treatments exert significant influence on nutrient content of maize and cowpea.

The mean N, P_2O_5 and K_2O content in the straw of T_1 Sole Maize were (1.59, 0.19 and 1.73 %) and T_2 Sole Cowpea were (2.27, 0.23, and 2.96 %) respectively. The maximum N, P_2O_5 and K_2O content in straw of maize and cowpea were recorded T_6 Maize + Cowpea (2:2) row ratio recorded (1.56, 0.18 and 1.70 %) in maize and cowpea were (2.26, 0.23 and 2.95 %) over rest of other treatments and it was on par with T_4 Maize + Cowpea (3:1) row proportion. Similar finding regarding crude protein content were observed Yadav and Chuodhary (2009).

Nutrient uptake (Table 2)

The treatments exert significant influence on nutrient uptake of maize and cowpea.The mean N, P and K uptake of T_1 Sole Maize (226.72, 44.49, and 390.45 kg ha^{-1}) and T_2 Sole Cowpea (118.99, 23.78, and 312.70 kg ha^{-1}) respectively. Among the intercropping the maximum N, P_2O_5 and K_2O content in straw of maize and cowpea were recorded T_6 Maize + Cowpea (2:2) row ratio recorded (215.95, 37.51 and 330.20 kg ha^{-1}) in maize and cowpea were (27.67, 13.23 and 172.72 kg ha^{-1}) over rest of other treatments and it was on par with T_4 Maize + Cowpea (3:1) row proportion. Similar finding regarding nutrient uptake were observed by Jat and Ahlawat (2013).

Economics (Table 3)

The treatments exert significant influence on economics of maize and cowpea. The sole crop of maize T_1 recorded highest cost of cultivation of (Rs. 64,750 ha^{-1}) than other treatment combinations. Among intercropping combinations treatment T_6 Maize + Cowpea (2:2) row ratio recorded significantly highest gross and net monetary return (Rs.1, 79, 382 and 1, 33, 257 ha^{-1}) and B:C ratio (3.88). However, T_4 Maize + Cowpea (3:1) row ratio intercropping system was statistically on par with each other. The maximum net return of (Rs.1,17,776 ha^{-1}) and B:C ratio (3.42) was recorded by this treatment.

The T_4 Maize + Cowpea (3:1) row ratio intercropping system recorded highest gross monetary return (Rs.1,66,302 ha^{-1}), net monetary return (Rs. 1,17,776 ha^{-1}) and B:C ratio (3.42) which was statistically on par with T_5 Maize + Cowpea 4:1 row ratio recorded gross return (Rs.1,63,131 ha^{-1}), net monetary return (Rs.1,15,183 ha^{-1}) and B:C ratio (3.40). Similar finding regarding economics were observed by Sharma *et al.* (2007) and Kumaresan *et al.* (2010).

Conclusions

Based on the above results, it may be concluded that instead of cultivating sole crop of maize is most profitable intercropping sytem and can be adopted to get higher monetary returns without deteriorating soil health.

Table 1: Nutrient content in straw of green fodder as influenced by maize + cowpea intercropping systems

Treatment	Maize (%)				Cowpea (%)	
	N	P	K	N	P	K
T_1 - Maize Sole	1.59	0.19	1.73	N/A	N/A	N/A
T_2 - Cowpea Sole	N/A	N/A	N/A	2.27	0.23	2.96
T_3 - M + C 1:1	1.33	0.17	1.67	2.11	0.21	2.65
T_4 - M+ C 3:1	1.51	0.19	1.73	2.21	0.23	2.88
T_5 - M + C 4:1	1.44	0.18	1.70	2.16	0.21	2.76
T_6 - M + C 2:2	1.56	0.18	1.70	2.26	0.23	2.95
T_7 - M+ C 3:2	1.46	0.17	1.69	2.10	0.22	2.69
S.E. (m) ±	0.01	0.01	0.01	0.01	0.01	0.01
C.D.at 5%	0.02	0.02	0.02	0.02	0.02	0.02

Table 2: Nutrient uptake by fodder crop as affected by maize + cowpea intercropping systems

Treatment	Maize kg ha^{-1}				Cowpea kg ha^{-1}	
	N	P	K	N	P	K
T_1 - Maize Sole	226.72	44.49	390.45	N/A	N/A	N/A
T_2 - Cowpea Sole	N/A	N/A	N/A	118.99	23.78	312.70
T_3 - M + C 1:1	118.62	25.78	249.90	21.52	10.70	120.57
T_4 - M+ C 3:1	185.55	35.63	298.40	23.53	11.69	155.73
T_5 - M + C 4:1	176.34	30.39	286.54	21.68	11.02	138.73
T_6 - M + C 2:2	215.95	37.51	330.20	27.67	13.23	172.72
T_7) M+ C 3:2	167.66	27.54	267.53	22.05	11.30	121.70
S.E. (m) ±	0.77	0.64	0.54	0.69	0.89	0.59
C.D.at 5%	2.38	1.96	1.65	2.14	2.73	1.81

Table 3: Economics of maize and cowpea intercropping systems

Treatments	Cost of cultivation (Rs ha^{-1})	Gross monetary Returns (Rs ha^{-1})	Net monetary Returns (Rs ha^{-1})	B:C Ratio
T_1 - Maize Sole	64750	171231	106481	2.64
T_2 - Cowpea Sole	26208	94803	68595	3.61
T_3 - M + C 1:1	46847	124395	77548	2.65
T_4 - M+ C 3:1	48526	166302	117776	3.42
T_5 - M + C 4:1	47948	163131	115183	3.40
T_6 - M + C 2:2	46125	179382	133257	3.88
T_7 - M+ C 3:2	47956	141051	93095	2.94

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