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Influence of intercropping system and integrated nitrogen management in maize (popcorn) (*Zea mays everta* L.) - chickpea (*Cicer arietinum* L.) intercropping under middle Gujarat conditions

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Abstract

A field experiment was conducted at Agronomy Farm, Anand Agricultural University, Anand to find out influence of intercropping system and integrated nitrogen management in maize (popcorn) (*Zea mays everta* L.) - chickpea (*Cicer arietinum* L.) intercropping during *rabi* season of 2017-18 and 2018-19. There were sixteen treatment combinations comprised of four intercropping systems viz., S₁: maize sole, S₂: chickpea sole S₃: maize - chickpea 1:1 and S₄: maize - chickpea 2:2 placed as main plot treatments and four integrated nitrogen management viz., N₁: 100 % RDN (Recommended Dose of Nitrogen), N₂: 75 % RDN + 25 % vermicompost N₃: 75 % RDN + 25 % FYM and N₄: 50 % RDN + 25 % vermicompost + 25 % FYM set as sub plot treatments in split plot design with four replications. The soil of experimental plot was loamy sand in texture. The soil was low in available nitrogen and medium in available phosphorous and in potash. Results revealed that maize crop intercropped with chickpea with 1:1 ratio recorded significantly higher cob length, cob girth, weight of cob, number of grains/cob, grain yield and stover yield of maize, and significantly higher plant height, number of nodules/plant, number of pods /plant, seed yield, dry fodder yield and harvest index of chickpea and higher maize equivalent yield. Integrated nitrogen management had remarkable impact on growth parameters, yield attributes and yield of maize - chickpea intercropping and significantly higher plant height, cob length, cob girth, weight of cob, number of grains /cob, grain yield, stover yield, protein content of maize, and number of nodules/plant, number of pods/plant, seed yield and haulm yield, harvest index, protein content of chickpea as well as maize equivalent yield were obtained with the crops fertilized with 50 % RDN + 25 % vermicompost + 25 % FYM.

Keywords: Chickpea, integrated nitrogen management, intercropping, maize, maize equivalent yield, RDN

Introduction

Maize is cultivated nearly about in 160 countries having wider diversity of soil, climate, biodiversity and management practices that contributes 36 per cent (782 million tons) global grain production. So, it is known as a "Queen of cereals" because of its maximum yield potential (22 t / ha) among the cereals. Maize is the third most important cereal crop in India after rice and wheat. Maize in India, contributes nearly 9 per cent in the national food basket. In India, maize is grown in an area of 9.86 million hectares with total production of 27.23 million tons with the productivity of 2764 kg / ha (Anon., 2018a) ^[1]. Nine states viz. Karnataka, Andhra Pradesh, Tamil Nadu, Rajasthan, Maharashtra, Bihar, Uttar Pradesh, Madhya Pradesh and Gujarat account for 85 per cent of India's maize production and 80 per cent of area under cultivation. In Gujarat, maize is grown over an area of 4.00 lakh hectares with an annual production of 719 tonnes with the productivity of 1782 kg / ha (Anon., 2018b) ^[2]. Though it is mostly cultivated in *kharif* season, *rabi* cultivation of maize is also getting importance due to its low pests and disease infestations and high responsiveness to better management practices resulting in to sustainable and higher productivity.

Different types of maize crop viz; Popcorn, Sweet corn, Baby corn, Flint corn, Dent corn, Flour corn and Pod corn are under cultivation. Popcorn (*Zea mays* var. *everta*) is a Native American plant grown for its tasty, exploding kernels. There are two main types of popcorn- rice type and pearl type. The rice type pop corn kernels are common in white grain types.

Popcorn is further classified as butterfly type and mushroom type. The butterfly type is preferred for eating, while mushroom type is used in confectionary products. At present, the cultivation of popcorn is concentrated in the outskirts of big cities and metropolis. The productivity levels of popcorn is very low due to non-availability of appropriate agro techniques and lack of awareness regarding their trade potential among the farmers and policy makers, the cultivation of popcorn has not been extended in other areas of country. The major objectives of intercropping are to produce an additional crop to optimize the use of natural resources besides providing certain insurance against biotic and environmental stresses and reduce the probability of failure of single crop. Among the pulses, chickpea is one of the most important and extensively cultivated pulse crops in *rabi* season. Its intercropping with maize (popcorn) definitely insure the risk of low productivity of popcorn, give additional income to the farmers as well as enrich the soil with fixation of atmospheric nitrogen and addition of organic manure in the soil. Nitrogen is the key element in achieving consistently high yield in cereals. Nitrogen is the most common limiting nutrient for crop production and therefore adoption of good nitrogen management strategies often results in large economic benefit to the farmers. Integrated nitrogen management refers to the maintenance of soil fertility and plant nitrogen supply at an optimum level for sustaining the desired productivity through optimization of the benefits from all possible sources of organic, inorganic and biological components in an integrated manner. A positive interaction has been shown to exist between the combination of organic manures and urea as N source (Bocchi and Teno, 1994) [3]. Nitrogen use efficiency of fertilizers is improved in the presence of FYM and other organic sources. An increase in the yield of crop can be brought forward either by increasing the area under cultivation or by increasing the productivity per unit area. Since the area is limited, yield level per unit area has to be increased. To achieve the goal, there is need to study on intercropping system and integrated nitrogen management.

Materials and Methods

A field experiment was conducted at Agronomy Farm, Anand Agricultural University, Anand to find out influence of integrated nitrogen management in maize (popcorn) (*Zea mays everta* L.) - chickpea (*Cicer arietinum* L.) intercropping system during *rabi* season of 2017-18 and 2018-19. There were sixteen treatment combinations comprised of four intercropping systems viz., S₁: maize sole, S₂: chickpea sole S₃: maize - chickpea 1:1 and S₄: maize - chickpea 2:2 placed as main plot treatments and four integrated nitrogen management viz., N₁: 100 % RDN (Recommended Dose of Nitrogen), N₂: 75 % RDN + 25 % vermicompost N₃: 75 % RDN + 25 % FYM and & N₄ : 50 % RDN + 25 % vermicompost + 25 % FYM set as sub plot treatments in split plot design with four replications. The soil of the experimental plot was loamy sand in texture. The soil was low in available nitrogen and medium in available phosphorous as well as in potash.

The crop was fertilized as per respective nitrogen treatments i.e. 100 % RDN (120 N kg / ha), 75 % RDN (90 kg N/ha) and 50 % RDN (60 kg N/ha) through urea. The remaining nitrogen was applied through FYM or vermicompost or FYM + Vermicompost to respective treatments with equivalent nitrogen quantity at the time of land preparation as basal dose. One - third quantity of inorganic nitrogen (urea) was given to

maize crop as a basal dose at the time of land preparation and remaining two third quantities was applied as top dressing in two equal splits at 30 and 60 DAS of sole as well as intercropped maize. Entire quantities of phosphorus to maize (60 kg P₂O₅ / ha) was applied as a common basal dose in furrow to all plots in form of SSP (single super phosphate). In sole chickpea entire quantity of nitrogen (20 kg N/ha) and phosphorus (40 kg P₂O₅/ha) was applied as a basal dose at the time of preparation of land. For intercropped chickpea no additional nutrient was applied. Maize (Popcorn) variety 'Amber' and chickpea variety 'GG 1' were selected for the experiment. Sole maize and sole chickpea were drilled at 60 cm and 30 cm spacing. Inter row spacing of 30 cm was kept while adopting intercropping systems of maize: chickpea in 1:1 and 2:2 ratios. The harvest index is the ratio of economic yield to the biological yield per plot. The harvest index for each treatment was worked out by using the formula given by Donald and Hamblin, 1976 [5].

$$\text{Harvest Index (\%)} = \frac{\text{Economic yield (kg / ha)}}{\text{Biological yield (kg / ha)}} \times 100$$

Maize equivalent yield was worked out for all the experimental units by following formula.

Maize Yield Equivalent (MYE)

$$= \text{Yield of maize} + \frac{(\text{Yield of chickpea} \times \text{Price of chickpea})}{\text{Price of maize}}$$

Results and Discussion

The data pertaining to various growth parameters, yield attributes and yield of grain/ seed and stover/ haulm yield of maize and chickpea, maize equivalent yield and harvest index of maize and chickpea intercrop as influenced by different intercropping systems and integrated nitrogen management (INM) with their statistical inferences are presented and discussed as under.

A. On growth parameters

a. Effect of intercropping systems

The mean data pertaining to periodical plant height of maize and chickpea (Table 1) measured periodically at 30, 60 DAS and at harvest as influenced by intercropping systems showed non-significant impact of the treatments on plant height of maize at any of the growth stages on pooled basis. However, different intercropping systems though failed to exert any remarkable influence on chickpea height during initial stage (30 DAS), at 60 DAS and at harvest significant difference in plant height of chickpea was observed due to intercropping systems and treatment S₂ (chickpea sole) produced the tallest plant at 60 DAS (51.18 cm) and at harvest (65.18 cm) on pooled basis. It was observed that in the intercropping systems maize growth was higher as compared to chickpea throughout the growth period that created smothering and shading effect on chickpea after 30 DAS and chickpea at later growth stages performed well under sole cropping due to efficient utilization of solar radiation caused increase in photosynthetic activity, metabolic activity and efficient utilization of applied nutrients compared to intercropping systems. These findings were confirmed with the observation of Prabhakar and Chandranath (2017) [17] and Modi (2016) [11].

b. Effect of integrated nitrogen management

Data pertaining to plant height of maize (Table 1) measured at 30 DAS as influenced by integrated nitrogen management

was found to be non - significant, however, at 60 DAS and at harvest it was found significant on pooled basis. At 60 DAS treatment N₂ (75 % RDN + 25 % vermicompost) gave significantly taller plant (186.87 cm), which was found at par with the treatment N₃ and N₄. Similar trend was observed at harvest and treatment N₂ (75 % RDN + 25 % vermicompost), being at par with treatments N₃ and N₄, recorded significantly higher plant height (219.76 cm). This might be due to constant supply of nitrogen throughout the growth period of maize due to blending of inorganic (75% N) and organic source (25% vermicompost) ascribing the synergistic effect of nitrogen on cell division and expansion, generating thin cell wall, promoting vegetative growth, increasing the formation of foliage by producing more carbohydrates which might be utilized in building up of new cells. This could be resulted in to increase in plant height. An increase in plant height of maize due to organic manures (FYM and Vermicompost) application has been reported by Ombase (2018) ^[15], Manjhi *et al.* (2016) ^[9] and Nagavani and Subbian (2014) ^[14]. Results for chickpea further revealed that different integrated nitrogen management had non - significant influence on the plant height measured at 30 and 60 DAS and at harvest in pooled analysis. Nitrogen requirement of chickpea might be sufficed for promoting enough vegetative growth, resulting in to homogeneous plant height.

c. Effect of interaction (SXN)

Plant heights of maize and chickpea at any of the growth stages were not affected due to interaction effects between intercropping systems and integrated nitrogen management.

B. On yield attributes

Data pertaining to yield attributes of maize and chickpea as influenced by intercropping system and integrated nitrogen management on pooled basis are presented in Table 2.

a. Effect of intercropping systems

Results revealed that number of cobs / plant and test weight of maize did not differ remarkably due to different intercropping systems. However, treatment S₃ (Maize (popcorn) - chickpea 1:1) recorded significantly highest cob length (15.72 cm) and weight of cob (221.41 g), whereas, the same treatment being at par with treatment S₄ (Maize (popcorn) - chickpea 2:2) reported significantly higher cob girth (12.87 cm) and number of grains / cob (377.42). The result might be due to lower competition for the nutrient uptake and space suitable for proper growth and development under 1:1 intercropping system. Besides this, atmospheric nitrogen fixation by chickpea as an intercrop could be utilized by component maize crop which might be resulted in to better source to sink relationship and converted the metabolites in to higher cob length and cob girth, which ultimately resulted in to higher weight of cob and higher number of grains/ cob in the same treatment. Similar trend was also observed by Jan *et al.* (2016) ^[7], Modi (2016) ^[11], Reddy and Pulled (2016) ^[19] and Yadav *et al.* (2016) ^[22].

In case of chickpea, though intercropping systems failed to exert any significant impact on number of seeds/pod and test weight, treatment S₂ (sole chickpea) produced significantly the highest number of nodules/plant (26.83) and number of pods/plant (48.36). The results might be attributed to less competition for natural resources like solar radiation, moisture and nutrient under sole chickpea compared to intercrop. These results are in conformity with the finding by Prabhakar and

Chandranath (2017) ^[17], Hamd alla *et al.* (2014) ^[6] and Popat (2012) ^[18].

b. Effect of integrated nitrogen management

Results shown in table 2 further manifested the effect of integrated nitrogen management on yield attributes of maize and chickpea as a sole crop and intercrop. Results revealed that number of cobs/plant and test weight being genetic characters, did not differ significantly, whereas, cob length, cob girth, weight of cob and had significant influence of integrated nitrogen management and treatment N₄ (50 % RDN + 25 % vermicompost + 25 % FYM) logged significantly higher cob length (15.44 cm), cob girth (12.71 cm), weight of cob (205.00 g) and number of grains/cob (361.06), however, it remained at par with N₂ for cob length and with N₂ and N₃ for cob girth and number of grains/cob. The results indicated the effect of balanced nitrogen supply through inorganic and organic combinations might increase the nitrogen use efficiency very efficiently and provide long term sustainability of soil which might suffice the nitrogen demand of the crop throughout the growth period. It might be also possible that vermicompost was proved more effective compared to FYM. Moreover, weight of cob and number of grains/cob were the resultant effect of higher length and girth of cob under N₄ treatment. The results were in conformity with Ombase (2018) ^[15], Lakum (2017) ^[8], Manjhi *et al.* (2016) ^[9] and Sindhi *et al.* (2016) ^[20].

Similarly, treatment N₄ (50 % RDN + 25 % vermicompost + 25 % FYM) documented significantly the highest number of nodules/plant (17.13) and number of pods/plant (45.57) over rest of the treatments. Number of seeds/pod and test weight, being genetic characters, were remained identical. Under treatment N₄ inorganic fertilizer boost the initial growth of chickpea and addition of partial nitrogen in the organic form by FYM and vermicompost after the decomposition might suffice the nitrogen demand of chickpea through constant mineralization of vermicompost and FYM. Same result was reported by Chhetri and Sinha (2018) ^[3].

c. Interaction effect

Interaction between S X N was found significant for weight of cob of maize and number of nodules/plant of chickpea (Table 4). Treatment combination S₃N₄, being at par with S₃N₂ recorded significantly higher weight of cob (239.13 g), whereas, same treatment combination S₃N₄ reported significantly the highest number of nodules/plant of chickpea (32.35).

C. On yields, Harvest Index and MEY

a. Effect of intercropping systems

Data pertaining to grain and stover yield of maize, seed and haulm yield of chickpea, harvest index of both the crops and maize Equivalent Yield (MEY) were showcased in Table 3. Results revealed significant effect of intercropping system on yields of maize with treatment S₃ (maize - chickpea 1:1) out yielded rest of the treatments with significantly the highest grain (3753 kg/ha) and stover (5196 kg/ha) yields of maize which were found 21 and 16.4 per cent higher for grain yield and 20 and 10.57 per cent higher for stover yield of maize over treatment S₁ and S₄, respectively. As far as chickpea was concerned treatment S₂ (sole chickpea) out yielded rest of intercropping treatments and produced significantly the highest seed (1308 kg/ha) and haulm (2481 kg/ha) yields which were registered 106.6 and 98.4 per cent higher seed yield and 55 and 46 per cent higher haulm yield over the

treatment S₃ and S₄, respectively. Though the harvest index for maize was remained unchanged, harvest index for chickpea was influenced statistically due to intercropping systems and treatment S₂ (maize - chickpea 1:1) logged significantly the highest harvest index (34.37). For MEY, treatment S₃ (maize - chickpea 1:1) produced significantly the highest MEY (5184 kg/ha) which was found higher to the tune of 68, 74 and 10 per cent over S₁, S₂ and S₄, respectively. Yield is the resultant effect of cumulative effect of all the growth and yield parameters. The highest growth and yield parameters were recorded under S₃ (maize - chickpea 1:1) for maize and under S₂ (sole chickpea) for chickpea. This might be due to the reason for higher yield performance of these two treatments for maize and chickpea. MEY is a calculation based on yield and price of the component crops; therefore, treatment S₃ (maize - chickpea 1:1) stood the highest. These finding are in conformity with those reported by Chetri and Shinha (2018) [3], Prabhakar and Chandranath (2017) [17], Massawe *et al.*, (2016) [10], Jan *et al.* (2016) [7] and Modi (2016) [11].

b. Effect of integrated nitrogen management

Data presented in Table 3 indicated that grain and stover yield of maize, seed and haulm yield of chickpea and harvest index of chickpea as well as maize equivalent yield were significantly influenced by integrated nitrogen management. However, harvest index of maize remained unaffected due to integrated nitrogen management. Results further shown that treatment N₄ (50% RDN + 25% Vermicompost + 25% FYM), being at par with treatment N₂ (75% RDN + 25% Vermicompost) produced significantly higher grain (3577 kg/ha) and stover (4922 kg/ha) yield of maize on pooled basis, which was 12.55 and 7.23 per cent higher grain and stover yield compared to N₁ (100 % RDN), respectively. The results pointed out that integrated application of nutrients through inorganic and organic sources might be more useful for plant growth. As blending of inorganic and organic sources of nitrogen, not only provided continuous availability of nitrogen throughout the crop growth of maize, but also helped to improve physico – chemical properties of the soil, which in turn improved microbial activity in the soil due to friability of soil with balanced soil moisture - soil air ratio. This impact were reflected in higher growth and yield attributes like plant height, cob length, cob girth, cob weight and number of grains / cob, as well as lower weed dry weight under the same treatment N₄. Besides addition of atmospheric nitrogen in the soil, over and above, regular application of nitrogen through integration of inorganic (50 % RDN) and organic (25 % vermicompost and 25 % FYM) helped to curtail the chemical load in the soil. These results are in conformity with findings of Chhetri and Sinha (2018) [3],

Lakum (2017) [8], Manjhi *et al.* (2016) [9], Sindhi *et al.* (2016) [20] and Yadav *et al.* (2016) [22].

For chickpea, though treatment N₄ (50 % RDN + 25% Vermicompost + 25 % FYM) produced significantly higher seed (930 kg/ha) and haulm (1977 kg/ha) yield, it remained at par with treatment N₂ (75% RDN + 25% Vermicompost) for seed yield and with treatments N₂ (75% RDN + 25% Vermicompost) and N₃ (75% RDN + 25% FYM) for haulm yield. Similar trend was followed for harvest index and treatment N₄ (50 % RDN + 25% Vermicompost + 25 % FYM), being at par with treatments N₂ (75% RDN + 25% Vermicompost) and N₃ (75% RDN + 25% FYM), noticed significantly higher harvest index (30.89 %) for chickpea. This might be due to the organic and inorganic combination of nitrogen which increased the availability of nitrogen at distinct physiological phases that would have supported for better source to sink ratio which resulted in to retrieval of yield characters like pods / plant. Furthermore, chickpea fixed atmospheric nitrogen symbiotically which could have been utilized for growth and yield attributing parameters. FYM and vermicompost leads to increase the availability of nitrogen along with improving physico - chemical properties of the soil. These results were in accordance to Nagavani and Subbian (2014) [14], Thavaprakash *et al.* (2005) [21] and Pathak *et al.* (2002) [16].

As far as maize equivalent yield (MEY) was concerned treatment N₄ (50 % RDN + 25% Vermicompost + 25 % FYM) out yielded rest of the treatments with significantly the highest MEY of 4270 kg/ha, which was higher to the tune of 15.71, 3.84 and 9.82 per cent over N₁, N₂ and N₃, respectively. These findings are in conformity with those reported by Lakum (2017) [8] and Mukherjee (2015) [13].

c. Interaction effect

Interaction effects between intercropping system and integrated nitrogen management manifested significant relationship for seed yield of chickpea and maize equivalent yield. Remaining interactions for grain and stover yield of maize, haulm yield of chickpea as well as harvest index of maize and chickpea were found unaffected (Table 4). Results further revealed that significantly the highest seed yield (1480 kg/ha) of chickpea was recorded under treatment combination S₂N₄ over rest of the treatment combinations. A close perusal of data further indicated that significantly higher MEY (5466 kg/ha) was recorded under treatment combination S₃N₄, which was found at par with treatment combination S₃N₄ (5348 kg/ha). Treatment combination S₃N₄ produced 83.91 percent higher MEY over S₁N₁ (sole maize + 100% RDN) and 70.54 percent higher MEY over S₁N₄ (sole maize + 50% RDN+25% Vermicompost + 25 % FYM).

Table 1: Periodical plant height (cm) of maize and chickpea as influenced by intercropping system and integrated nitrogen management on pooled basis

Treatments	Plant height (cm)					
	At 30 DAS		At 60 DAS		At Harvest	
	Maize	Chickpea	Maize	Chickpea	Maize	Chickpea
Intercropping system (S)						
S ₁ : Maize (popcorn) sole	72.34	-	178.98	-	205.77	-
S ₂ : Chickpea sole	-	18.18	-	51.18	-	65.18
S ₃ : Maize (popcorn) - chickpea (1:1)	73.57	17.46	184.35	45.46	215.65	59.24
S ₄ : Maize (popcorn) - chickpea (2:2)	70.16	17.88	180.90	45.88	210.72	59.88
S.E.m. ±	1.24	0.27	3.26	0.88	3.88	0.99
C.D. at 5 %	NS	NS	NS	2.71	NS	3.05
C.V. %	9.75	8.55	10.17	10.48	10.42	9.13

Integrated nitrogen management (N)						
N ₁ : 100 % RDN (120 kg / ha nitrogen)	73.47	17.53	169.03	47.20	197.20	61.20
N ₂ : 75 % RDN + 25 % Vermicompost	72.01	17.81	186.87	47.48	219.76	61.31
N ₃ : 75 % RDN + 25 % FYM	71.56	17.65	185.72	47.31	214.45	61.19
N ₄ : 50 % RDN+ 25 % Vermicompost + 25 % FYM	71.05	18.37	184.01	48.04	211.44	62.04
S.E.m. \pm	1.04	0.29	3.10	0.85	3.52	0.94
C.D. at 5 %	NS	NS	8.79	NS	9.99	NS
C.V. %	7.05	7.94	8.79	8.73	8.19	7.53
Significant interaction (S x N)	NS	NS	NS	NS	NS	NS

Table 2: Yield attributes of maize and chickpea as influenced by intercropping system and integrated nitrogen management on pooled basis

Crop Treatments	Maize						Chickpea			
	Number of cobs / plant	Cob length (cm)	Cob girth (cm)	Weight of cob (g)	Test weight (g)	Number of grains / cob	Number of nodules / plant (30 DAS)	Number of pods / Plant	Number of seeds / Pod	Test weight (g)
Intercropping system (S)										
S ₁ : Maize (popcorn) sole	1.52	14.18	11.28	154.56	143.36	296.23	-	-	-	-
S ₂ : Chickpea sole	-	-	-	-	-	-	26.83	48.36	1.91	182.26
S ₃ : Maize (popcorn) - chickpea (1:1)	1.56	15.72	12.87	221.41	149.34	377.42	7.73	36.35	1.84	179.20
S ₄ : Maize (popcorn) - chickpea (2:2)	1.53	14.47	12.55	190.47	145.33	374.43	9.83	41.97	1.86	179.90
S.E.m. \pm	0.03	0.25	0.23	3.07	2.52	6.42	0.26	0.72	0.03	2.72
C.D. at 5 %	NS	0.77	0.70	9.46	NS	19.78	0.80	2.23	NS	NS
C.V. %	9.76	9.57	10.58	9.20	9.77	10.40	9.99	9.68	9.91	8.52
Integrated nitrogen management (N)										
N ₁ : 100 % RDN (120 kg / ha nitrogen)	1.51	13.91	11.47	176.17	146.25	326.03	12.35	39.63	1.85	179.51
N ₂ : 75 % RDN + 25 % Vermicompost	1.53	15.13	12.43	193.83	145.85	359.28	15.78	42.61	1.87	180.93
N ₃ : 75 % RDN + 25 % FYM	1.52	14.68	12.32	180.25	145.16	351.07	13.93	41.09	1.84	179.76
N ₄ : 50 % RDN+ 25 % Vermicompost + 25 % FYM	1.57	15.44	12.71	205.00	146.33	361.06	17.13	45.57	1.92	181.61
S.E.m. \pm	0.03	0.26	0.22	3.15	2.64	6.34	0.28	0.67	0.03	2.94
C.D. at 5 %	NS	0.75	0.61	8.94	NS	17.97	0.80	1.89	NS	NS
C.V. %	8.90	8.74	8.68	8.18	8.87	8.89	9.29	7.75	8.77	7.98
Significant interaction (S x N)	NS	NS	NS	Sig.	NS	NS	Sig.	NS	NS	NS

Table 3: Yields, harvest index and maize equivalent yield of maize and chickpea as influenced by intercropping system and integrated nitrogen management on pooled basis

Treatments	Maize			Chickpea			Maize equivalent yield (kg/ha)
	Grain yield (kg/ha)	Stover yield (kg/ha)	Harvest Index (%)	Seed yield (kg / ha)	Haulm yield (kg/ha)	Harvest Index (%)	
Intercropping system (S)							
S ₁ : Maize (popcorn) sole	3082	4330	41.58	-	-	-	3081
S ₂ : Chickpea sole	-	-	-	1308	2481	34.37	2975
S ₃ : Maize (popcorn) - chickpea (1:1)	3753	5196	41.92	633	1605	28.34	5184
S ₄ : Maize (popcorn) - chickpea (2:2)	3222	4699	40.67	659	1691	28.08	4719
S.Em. \pm	60	81	0.63	16	36	0.48	64
C.D. at 5 %	186	250	NS	49	113	1.47	192
C.V. %	10.16	9.68	8.69	10.59	10.78	8.94	9.18
Integrated nitrogen management (N)							
N ₁ : 100 % RDN (120 kg / ha nitrogen)	3178	4590	41.06	767	1838	29.35	3690
N ₂ : 75 % RDN + 25 % Vermicompost	3447	4797	41.79	895	1955	30.41	4112
N ₃ : 75 % RDN + 25 % FYM	3197	4658	40.62	874	1932	30.39	3888
N ₄ : 50 % RDN+ 25 % Vermicompost + 25 % FYM	3577	4922	42.11	930	1977	30.89	4270
S.Em. \pm	55	74	0.58	13	28	0.34	47
C.D. at 5 %	158	212	NS	37	81	0.97	133
C.V. %	8.16	7.74	6.90	7.46	7.32	5.33	6.79
Significant interaction (S x N)	NS	NS	NS	Sig.	NS	Sig.	Sig.

Table 4: Interaction effect of S x N on weight of cob, number of nodules/plant and harvest index on pooled basis.

Treatments	Weight of cob (g) of maize				Number of nodules / plant of chickpea				Harvest index (%) of Chickpea			
	S ₁	S ₂	S ₃	S ₄	S ₁	S ₂	S ₃	S ₄	S ₁	S ₂	S ₃	S ₄
N ₁	137.50	-	202.00	189.00	-	21.17	6.85	9.02	-	29.99	30.26	27.79
N ₂	171.00	-	224.75	185.75	-	29.15	7.90	10.27	-	35.75	27.48	27.99
N ₃	137.25	-	219.75	183.75	-	24.62	7.75	9.40	-	35.07	27.84	28.23
N ₄	172.50	-	239.13	203.38	-	32.35	8.42	10.60	-	36.65	27.76	28.26
S.E.m. \pm	5.46				0.51				0.66			
C.D. at 5 %	15.48				1.48				1.94			

Table 5: Interaction effect of S x N on seed yield of chickpea and maize equivalent yield on pooled basis

Treatments	Seed yield (kg / ha) of chickpea				Maize equivalent yield (kg / ha)			
	S ₁	S ₂	S ₃	S ₄	S ₁	S ₂	S ₃	S ₄
N ₁	-	1014	647	639	2972	2305	5031	4454
N ₂	-	1399	622	663	3135	3181	5348	4782
N ₃	-	1341	623	657	3012	3049	4889	4601
N ₄	-	1480	637	675	3205	3363	5466	5040
S.E.m. ±	19				110			
C.D. at 5 %	56				318			

Conclusion

In light of the above two years' experiment, it could be concluded that maize (popcorn) should be intercropped with chickpea in 1:1 ratio and the maize crop should be fertilized with 50% of RDN (60 kg N/ha) through inorganic source (Urea) and remaining 50 % RDN through organic source as half from Vermicompost (30 kg N/ha) and half from FYM (30 kg N/ha) to obtain higher grain and stover yield of maize, seed and haulm yield of chickpea and higher maize equivalent yield along with curtailing 50 % chemical load in the soil.

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