Original Research Article

Impact of Organic and Inorganic Nutrient Sources on Yield Attributes and Yield of Maize-Mustard Cropping System

Abstract:

Soil quality deterioration, especially in intensive cropping system has become a serious problem for crop productivity. Consequently, strategies for sustainable crop production and soil health are urgently required. Therefore, a field experiment was conducted to study the impact of organic and inorganic nutrient sources on yield attributes and yield of maize-mustard cropping system during two consecutive *kharif* and *rabi* seasons of 2019-20 and 2020-21, respectively. The experiment was laid out in randomized block design assigning eight treatments of organic and inorganic nutrient sources comprising of (T_1) RDF (120:60:40 kg $N:P_2O_5:K_2O$ ha^{-1}), (T_2) RDF + Zn, (T_3) RDF + S, (T_4) RDF + Zn + S, (T_5) RDF + VC (5 t ha^{-1}), (T_6) RDF + VC (10 t ha^{-1}), (T_7) RDF + FYM (5 t ha^{-1}) and (T_8) RDF + FYM (10 t ha^{-1}) and were replicated thrice. The results reported that the higher yield attributes and yield of maize *viz.*, number of cobs $plant^{-1}$**,** number of grains cob^{-1}, cob length, grain yield, stover yield and biological yield and for mustard *viz*., siliquae $plant^{-1}$, number of seeds $siliquae^{-1}$, length of siliquae, seed yield, stover yield and biological yield were recorded with application of RDF + VC (10 t ha^{-1}) which was statistically at par with RDF + FYM (10 t ha^{-1}). However, seed index/test weight and harvest index of maize-mustard cropping was failed to show any significant effect due to above treatments.

Keywords: Siliquae, cropping system, deterioration, inorganic and elemental sulphur.

Introduction:

Food security has long been a major concern in India, with memories of serious famines and with a rapidly increasing population. The promotion of the production and use of fertilizers in order to increase crop yields has been a major objective of the Government of India for more than 30 years. The policy has succeeded and food production in India has kept pace with requirements. The forecast population of 140 million by 2025 will require 300 million tons of food grain compared with about 200 million tons of today. Little extra land is available and the increase in production will have to come from higher yields, for which there is ample scope (Aulakh *et al.,* 2009).

Among the various cereals namely rice and wheat have been under the main focus for achieving food security. However, maize has emerged as the third most important cereal crop after rice and wheat (Paramasivan *et al.*, 2010). It is the staple food for vast rural population of our country. Maize (*Zea mays* L.) has high genetic potential than any other cereals crops. Hence, it is known as “miracle crop” and also as “queen” of cereals (Singh *et al.,* 2017). Maize is an annual plant which belongs to family Gramineae. It is the American Indian word for corn which means ‘to sustain life’. It is cultivated globally as one of the most important cereal crops. It is a versatile crop grown over a range of agro climatic zones and provides food, feed, fodder and serves as sources of basic raw material for the number of industrial products *viz.,* starch, protein, oil, alcoholic beverages, food sweeteners, cosmetics, more recently as bio-fuel etc. No other cereal is being used in as many ways as maize. It occupies an important place as a source of human food (25%), animal feed (12%), poultry feed (49%), starch (12%) and 1% each in brewery and seed.

Oilseeds are backbone of agricultural economy of India since long and considered as the second largest agricultural commodity in India after cereals. The oil seed scenario has undergone dramatic change in recent years wherein, the oilseeds become a net foreign exchange earner leading to "Yellow revolution". Oilseeds are rich source of energy and nutrition. Edible oils and oil meals have pivotal role in relieving malnutrition and calorie nutrition of human beings and animal kingdom (Shukla *et al*., 2002).

Rapeseed/mustard is the third major oilseed of India, ranking after groundnut and soybean with around 23 per cent share of total oilseed production (Rajak *et al.,* 2011). It is one of the most important oilseed crop of global economic importance and belongs to the family Cruciferae.

The most important aspects of getting good yield of maize and mustard are the proper nutrient management. Maize is a heavy feeder crop and its productivity is mainly dependent on nutrient management. The adequate and balanced supply of plant nutrients is of critical importance in improving the productivity of crops. Chemical fertilizers are considered as the primary source of plant nutrients. But the soils which received nutrients only through chemical or synthetic fertilizers are showing declining productivity despite of being supplied with sufficient nutrients. Chemical fertilizers no doubt have boosted the crop growth and yield, but to a large extent these have contributed to deterioration of soil physical, chemical and biological condition (Mehta *et al.,* 2005). Excessive use of chemical fertilizers has been associated with decline in soil physical and chemical properties and crop yield (Kumar *et al*., 2016) and significant land problem such as degradation due to over exploitation of land, soil pollution caused by high application rate of fertilizer and pesticide application (Singh *et al*., 200). Excessive soil degradation, high fertilizer cost and low purchasing power of the farming community leads to rethink about alternatives. Unlike chemical fertilizers, organic manure is available at lower price. Organic manure because of their low nutrient content can not fulfill country's requirement for crop production. Therefore, a combination of organic manures with chemical fertilizers in the form of integrated manure appears to be best alternatives (Srinivasrao *et al*., 2003). Application of both organic and inorganic fertilizers not only increases the crop yield also to maintain the soil physical, chemical and biological conditions. The organic sources besides supplying N, P and K also make unavailable sources of elemental nitrogen, bound phosphates and micronutrients into available form to facilitate plant to absorb the nutrients.

However, information regarding organic and inorganic nutrient sources on maize-mustard cropping system in Uttar Pradesh is lacking. Keeping in view the above discussed facts of sufficient information and sparce related research, the present investigation was undertaken to find out the impact of organic and inorganic nutrient sources on yield attributes and yield of maize-mustard cropping system under Gazipur conditions.

Comment [SSK1]: sparse

Material and Methods:

The experiment was conducted during two consecutive *kharif* and *rabi* seasons of 2019-20 and 2020-21, respectively at farmers field of Village Tulsipur, Post- Bikrampur, Ghazipur, Uttar Pradesh, situated at latitude of 25^{o} 36' North and longitude of 83^{o} 09' East, with altitude of 86.0 meters above the mean sea level. The total rainfall experienced during the *kharif* was 780.1 mm in 2019 and 1140.3 mm in 2020 however, in *rabi* season rainfall was received *i.e.* 29.4 and 53.7 mm during 2019-20 and 2020-21, respectively. The experiment was laid out in randomized block design assigning eight treatments of organic and inorganic nutrient sources comprising of (T_1) RDF (120:60:40 kg $N:P_2O_5:K_2O$ ha^{-1}), (T_2) RDF + Zn, (T_3) RDF + S, (T_4) RDF + Zn + S, (T_5) RDF + VC (5 t ha^{-1}), (T_6) RDF + VC (10 t ha^{-1}), (T_7) RDF + FYM (5 t ha^{-1}) and (T_8) RDF + FYM (10 t ha^{-1}) and were replicated thrice.

The soil of the experimental field was sandy clay loam in texture having slightly alkaline in reaction (pH 7.21 & 7.20), low in organic carbon (0.36 & 0.37%) and available nitrogen (174.96 & 185.29 kg ha^{-1}), but medium in available phosphorus (20.13 & 20.69 kg ha^{-1}) and potassium (192.06 & 216.98 kg ha^{-1}) during first and second year, respectively. Sulphur and zinc nutrition (Each 25 kg ha^{-1}) through elemental sulphur and chelated zinc, respectively were applied as basal dose during both the experimental years. Nitrogen was applied 50% as basal and remaining in two equal splits. Azad Kamal variety of maize and Varuna variety of mustard were used for sowing of experiment. Application of organic and inorganic nutrient sources were done as per treatment. Other crop management practices were followed as per the recommendation of the area. Observation were recorded as per standard procedure. The recorded data were subjected to statistical analysis as prescribed by Gomez and Gomez (1984). The interpretation of the treatment effects were made on the basis of Fisher's critical difference at *p*=0.05 level.

Results and Discussions:

Effect on organic and inorganic nutrient sources on maize

Organic and inorganic nutrient sources influenced the yield attributes and yield of maize except for seed index (g) and harvest index (Table 1-2).

By critical probing of data (Table 1), it is evident that the significantly higher number of cobs plant^{-1} (1.97 and 2.00), number of grains cob^{-1} (505.55 and 511.27) and cob length (21.76 and 21.63 cm) were was produced with application of RDF + VC (10 t ha^{-1}) which was statistically at par with RDF + FYM (10 t ha^{-1}) during both the years of investigations. However, least values of these yield attributes were observed with application of RDF (120:60:40 N:P_2O_5:K_2O ha^{-1}) during both the experimental years. This might be due to application of RDF along with 1.0 t ha^{-1} of vermicompost or farm yard manure might have improved nutritional environment of rhizosphere as well as plant system as evident from the uptake and available status of soil nutrients and also translocation of food assimilates from sources to sink effectively, resulting in higher yield attributes *viz.,* cob length, number of grains cob^{-1}, grain yield plant^{-1} leading to higher grain yield. The results of the present study that Combined use of organic manure and chemical fertilizer has been found to be providing higher productivity with those reported by Ramesh *et al*. (2008); Singh *et al*. (2009); Dadarwal *et al*. (2009); Kannan *et al*. (2013); Singh *et al*. (2010); Behera and Singh (2009); Paradkar *et al*. (2010); Sharma and Banik (2012).

Different organic and inorganic nutrient sources applied to maize crop failed to exhibit significant difference in seed index. The maximum seed index (23.38 and 23.44 g) was recorded with application of RDF + VC (10 t ha^{-1}) however effect was found to be non-significant during both the years.

Significantly higher grain yield (3700 and 3819 kg ha^{-1}), stover yield (7930 and 8017 kg ha^{-1}) and biological yield (11630 and 11836 kg ha^{-1}) of maize was recorded in application of RDF + VC (10 t ha^{-1}) which was statistically at par with RDF + FYM (10 t ha^{-1}) during

Comment [SSK2]: pl check it

both the years of investigations (Table 2). However, significantly least grain yield, stover yield and biological yield was observed with application of RDF (120:60:40 N:P_2O_5:K_2O ha^{-1}) during both the years. This result may be attributed to high number of cobs $plant^{-1}$, number of grains cob^{-1}, cob length (Mehta *et al.*, 2011). The highest grain yield realized with application of organic and inorganic nutrient sources for plant nutrition could be ascribed due to its profound influence on vegetative and reproductive growth of the crop. This indicates that maize responds well to integrated nutrient management. The results of the present investigation indicating positive response of maize crop to balanced fertilization are alike to findings of several researchers (Kumpawat, 2004; Kumar, 2008; Singh and Choudhary, 2008 and Mehta *et al.*, 2011).

Comment [SSK3]: ?

Higher stover yield and biological yield is application of RDF + VC (10 t ha^{-1}) could be ascribed to their direct influence on dry matter production in leaf and stem at successive stages by virtue of increased photosynthetic efficiency. The profound influence of nutrient application on biological yield seems to be on account of its influence on vegetative (stover) and reproductive growth (grain) with those reported by Singh *et al.*, 2006; Kar *et al.*, 2006 and Choudhary *et al*., 2007.

Comment [SSK4]: Sentence is not clear

Organic and inorganic nutrient sources in general recorded the lowest (29.24 & 29.43%) value of harvest index in application of RDF (120:60:40 N:P_2O_5:K_2O ha^{-1}) whereas, RDF + VC (10 t ha^{-1}) recorded the highest (31.74 & 32.28%) harvest index during both the experimental years. However, treatments were failed to show any significant variation amongst themselves.

Effect on organic and inorganic nutrient sources on mustard

Data regarding yield attributes and yield have been summarized and presented in Table 3&4. Yield attributes and yield of mustard significantly influenced due to imposed treatments in both the years except for test weight and harvest index.

A scanning of the data (Table 3) clearly indicated that different organic and inorganic nutrient sources had significant effect on siliquae $plant^{-1}$, number of seeds $siliquae^{-1}$ and length of siliquae. The maximum number of siliquae $plant^{-1}$ (209.18 and 211.41), seeds $siliquae^{-1}$ (17.34 and 17.49) and siliquae length (7.16 and 7.27 cm) were obtained with application of RDF + VC (10 t ha^{-1}) which was statistically at par with RDF + FYM (10 t ha^{-1}) than rest of the treatments during both the years. However, least values of these attributes were obtained with application of RDF (120:60:40 N:P_2O_5:K_2O ha^{-1}).

An examination of data (Table 3) revealed that different organic and inorganic nutrient sources failed to show any significant effect on test weight. The maximum test weight (4.96 and 4.98 g) was obtained with application of RDF + VC (10 t ha^{-1}) while minimum with application of RDF (120:60:40 $N:P_2O_5:K_2O$ ha^{-1}) during both the experimental years.

Comment [SSK5]: If test weight is non significant, how grain yield will be significant? Pl check it. There is always highly positive correlation between test weight and grain yield.

It is evident from the data given in Table 4 that different nutrient sources caused significant variation in seed yield, stover yield and biological yield of mustard (Table 4). The significant improvement in the maximum seed yield (1826 and 1869 kg ha^{-1}), stover yield (4315 and 4378 kg ha^{-1}) and biological yield (6141 and 6247 kg ha^{-1}) were recorded with application of RDF + VC (10 t ha^{-1}) which was statistically at par with RDF + FYM (10 t ha^{-1}) during both the years. However, minimum yield (seed, stover and biological) was pertaining with application of RDF (120:60:40 $N:P_2O_5:K_2O$ ha^{-1}) during both the years of investigations.

Different organic and inorganic nutrient sources significantly influenced the yield attributes and yield of mustard. In the present investigation, organic and inorganic nutrient sources differed significantly in their ability to produce number of siliquae $plant^{-1}$, number of seeds $siliquae^{-1}$ and siliqaue length. Seed, stover and biological yield differed significantly by various organic and inorganic nutrient sources with application of RDF + VC (10 t ha^{-1}) except the harvest index of mustard. Mustard cultivation through application of RDF + VC (10 t ha^{-1}) and RDF + FYM (10 t ha^{-1}) had almost similar seed, stover and biological yield during both the years.

The increase in yield and yield attributes with combined effect of different sources of nutrients might be due to the fact that organic and inorganic fertilizers significantly increased the vegetative growth parameter resulting in more synthesis of plant metabolites like carbohydrates and proteins etc. which ultimately might have resulted in increased yield of mustard. The results are also in cognizance with Shukla *et al*. (2002); Rao and Shaktawat (2002). Also increased availability of secondary and micronutrient elements could be the possible reason for its spectacular influence on yield of mustard.

The data on harvest index showed non-significant difference by organic and inorganic nutrient sources are presented in Table. 4. Maximum harvest index (30.08 and 30.29%) was recorded with application of RDF + FYM (10 t ha^{-1}) than rest of the treatments during both the years of study.

Conclusions:

From the above overall study, it is recommended that to obtain higher yield attributes and yield of maize-mustard cropping system should be grown with combined application of RDF + VC (10 t ha^{-1}) under ago-climatic conditions of Ghazipur region of Eastern Uttar Pradesh.

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Table 1: Number of cobs plant^{-1}, grains cob^{-1}, cob length and seed index influenced by different organic and inorganic nutrient sources of maize crop

	Treatments	Yield attributes							
		No. of cobs plant^{-1}		No. of grains cob^{-1}		Cob length (cm)		Seed index (g)	
		2019	2020	2019	2020	2019	2020	2019	2020
T_1	RDF (120:60:40)	1.09	1.11	316.25	321.25	15.29	15.38	22.78	22.84
T_2	RDF + Zn	1.22	1.25	357.23	359.85	16.94	17.05	22.89	22.92
T_3	RDF + S	1.29	1.31	376.03	379.51	17.14	17.26	22.97	23.02
T_4	RDF + Zn + S	1.38	1.41	388.72	391.47	17.83	17.91	23.02	23.09
T_5	RDF + VC (5 t ha^{-1})	1.52	1.55	424.86	429.57	19.82	19.89	23.27	23.34
T_6	RDF + VC (10 t ha^{-1})	1.97	2.00	505.55	511.27	21.76	21.63	23.38	23.44
T_7	RDF + FYM (5 t ha^{-1})	1.47	1.54	401.72	406.24	19.63	19.58	23.09	23.12
T_8	RDF + FYM (10 t ha^{-1})	1.83	1.82	481.86	500.67	20.17	20.29	23.35	23.33
	SEm±	0.05	0.06	9.35	10.09	0.78	0.81	0.67	0.69
	CD at 5%	0.16	0.17	28.09	30.27	2.37	2.42	NS	NS

Table 2: Grain yield, stover yield, biological yield and harvest index influenced by different organic and inorganic nutrient sources of maize crop

	Treatments	Yield (kg ha^{-1})						Harvest index (%)	
		Grain yield		Stover yield		Biological yield			
		2019	2020	2019	2020	2019	2020	2019	2020
T_1	RDF (120:60:40)	2526	2597	6113	6226	8639	8823	29.24	29.43
T_2	RDF + Zn	2745	2802	6455	6574	9200	9376	29.84	29.88
T_3	RDF + S	2901	2967	6654	6637	9555	9604	30.36	30.89
T_4	RDF + Zn + S	3014	3089	6866	6912	9880	10001	30.51	30.89
T_5	RDF + VC (5 t ha^{-1})	3212	3292	7242	7303	10454	10595	30.73	31.07
T_6	RDF + VC (10 t ha^{-1})	3700	3819	7930	8017	11630	11836	31.74	32.28
T_7	RDF + FYM (5 t ha^{-1})	3126	3247	7011	7014	10137	10261	30.74	31.15
T_8	RDF + FYM (10 t ha^{-1})	3581	3709	7742	7854	11323	11563	31.63	32.08
	SEm±	110	113	216	223	337	346	1.25	1.29
	CD at 5%	334	341	652	671	1012	1038	NS	NS

Table 3: Number of siliquae plant^{-1}, seeds siliquae^{-1}, siliquae length and test weight of mustard crop influenced by different organic and inorganic nutrient sources

Treatments		Yield attributes							
		Siliquae plant^{-1}		Seeds siliquae^{-1}		Siliquae length (cm)		Test weight (g)	
		2019-20	2020-21	2019-20	2020-21	2019-20	2020-21	2019-20	2020-21
T_1	RDF (120:60:40)	141.10	143.17	12.67	12.78	6.35	6.47	4.48	4.52
T_2	RDF + Zn	153.31	154.75	13.84	13.96	6.48	6.61	4.59	4.63
T_3	RDF + S	166.14	169.64	14.24	14.38	6.67	6.78	4.64	4.67
T_4	RDF + Zn + S	174.95	177.47	14.65	14.79	6.73	6.86	4.69	4.74
T_5	RDF + VC (5 t ha^{-1})	187.31	189.74	15.98	16.12	6.97	7.09	4.81	4.86
T_6	RDF + VC (10 t ha^{-1})	209.18	211.41	17.34	17.49	7.16	7.27	4.96	4.98
T_7	RDF + FYM (5 t ha^{-1})	182.09	184.61	15.74	15.91	6.84	6.99	4.78	4.82
T_8	RDF + FYM (10 t ha^{-1})	198.47	200.41	17.11	17.26	7.02	7.15	4.89	4.92
	SEm±	6.18	6.70	0.43	0.44	0.05	0.05	0.24	0.26
	CD at 5%	18.54	20.14	1.29	1.33	0.15	0.17	NS	NS

Table 4: Seed yield, stover yield, biological yield and harvest index of mustard crop influenced by different organic and inorganic nutrient sources

	Treatments	Yield (kg ha^{-1}) Seed yield		Stover yield		Biological yield		Harvest index (%)	
		2019-20	2020-21	2019-20	2020-21	2019-20	2020-21	2019-20	2020-21
T_1	RDF (120:60:40)	1341	1382	3279	3315	4620	4697	29.03	29.42
T_2	RDF + Zn	1449	1495	3419	3468	4868	4963	29.77	30.12
T_3	RDF + S	1529	1574	3649	3701	5178	5275	29.53	29.84
T_4	RDF + Zn + S	1586	1634	3712	3768	5298	5402	29.94	30.25
T_5	RDF + VC (5 t ha^{-1})	1645	1681	3994	4057	5639	5738	29.17	29.30
T_6	RDF + VC (10 t ha^{-1})	1826	1869	4315	4378	6141	6247	29.73	29.92
T_7	RDF + FYM (5 t ha^{-1})	1625	1671	3934	3989	5559	5660	29.23	29.52
T_8	RDF + FYM (10 t ha^{-1})	1793	1841	4167	4237	5960	6078	30.08	30.29
	SEm±	59	61	106	111	142	151	0.45	0.51
	CD at 5%	178	184	319	334	428	453	NS	NS