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Impact of Organic, Inorganic and Biofertilizers on Crop Yield and N, P and K Uptake under Rainfed Maize-Wheat Cropping System

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Integrated effect of organic, inorganic and biofertilizers on crop yield and N,P and K uptake under rainfed maize-wheat cropping system and available nutrients during 2015-2016 is being studied in sandy loam at Jammu under the INM maize-wheat trial. The results revealed that the application of recommended levels of NPK to maize-wheat with FYM, VC and biofertilizers (Azotobacter and phosphate solubilizing bacteria) resulted in grain 66.53 per cent and straw 13.00 per cent increase over control in maize and wheat yields, respectively. Increasing levels of 50% N + recom. P + K + S + Zn + B +Vermicompost +Azotobactera + Phosphorus Solubilizing Bacteria significantly increased the yield of both the crops. Integrated use of organic, inorganic and biofertilizers improved the soil status of available N, P, K, S, (116.09, 14.22, 124.61, 9.41kg ha^{-1}), Zn and B (0.56 and 0.48mg kg^{-1}), over the initial values. A declining trend (N 70.05, P 9.14, K110.13, S 8.14 kg ha^{-1} Zn 0.36 mg $kg^{-1}$and 0.34 kg ha^{-1}) from the initial value of available nutrients. Increasing level of total uptake in maize N, P, K, S, Zn and B. This indicates a considerable mining of INM from the soil and suggest the need to adopt judicious organic, inorganic and biofertilizers.

Introduction

Rain fed agriculture contributes 58% of global food basket and constitutes 66% of the net sown area in India. Site specific nutrient management has received considerable attention due to potential benefits of increasing input use efficiency, improving economic margins of crop production and reducing environmental risks. Hence, a comprehensive understanding of spatial variability of soil properties is becoming increasingly essential in agriculture as soil properties vary from field to a large region scale and are influenced by geology, topography climate as well. The Kandi belt consisting of sub mountainous area of Jammu region arising from Punjab plains with gentle

slope of nearly three degrees and touching with low hilly Siwalik system of rocks lies in the outer Himalayas of Jammu region. The soils of this region are of lithosols type having undulated topography and scrub forest. Loss of organic matter, whether by erosion or high temperature in the rainfed agro-ecosystem, adds, to improvement of soil resources of several elements essential for plants growth. A decline in organic matter multiplies nutrient deficiency, it falls by the two-thirds symbolizes a serious suppression in nutrient availability. In addition, fertilizer consumption in rainfed areas is very low. The challenge of improving productivity in rainfed areas can be addressed by efficient utilization of available nutrients. Efficient nutrient management demands understanding the pathways of nutrient losses through gaseous loss, leaching loss, erosion and runoff losses and developing technologies to minimize these losses. Many water-soluble nutrients are lost through run off during intense rainfall and nutrients absorbed on the surface of soil particles-clays and silts and soil organic matter are lost when the top soil is eroded by water or wind. These losses of nutrients are not merely economic losses but may cause serious environmental problems and hence must be controlled by developing appropriate site-specific technologies. The native available nutrients should be optimally allocated among the crops to get maximum returns by allowing optimization of nutrient production functions which relate the crop responses to applied nutrients under given soil, climate, and management factors under rainfed conditions. To avoid any risk, the fertilizer recommendation in the rainfed region should be made only in the linear response range. Fertilizer allocation to crops based on soil test and crop correlation under rainfed condition for achieving targeted yield can help in improving nutrient use efficiency by crops. The yield targets can be decided based on availability of water other inputs and financial condition of the farmer depending on the inherent particular nutrient status of the soils (Sharma *et al.*, 2017).

Materials and Methods

The present investigation is a part of an ongoing experiment with maize-wheat cropping system in progress since kharif and rabi 2015 and 2016 at Advance center for rainfed Agriculture Rakh Dhainsar, SKUAST-Jammu and Department of Soil Science and Agricultural Chemistry, Chatha, Jammu Jammu and Kashmir (32^0 39' N and $74^0$58 E). Dhainsar, Jammu has a sub-tropical climate with a characteristic feature dry and cold winter. In winter season i.e. Oct to March the temperature 2 to 20 0c and the relative humidity 41 to 65%.Gernerally, dry and warm weather prevails during the months of March to June. The temperature in the month of May reaches as high as 48 0C. Monsoon season extends from first of July to mid-September. Total annual rainfall varies from 1049.2 mm to 1304 mm with the mean value of around mm. The length of growing period of both the crops ranges from 200 to 210 days. The soil of the experimental field is sandy loam in texture having pH (6.67), Bulk density(1.64 Mg m-3), Water holding capacity (11.01%), Cation exchange capacity (8.14 C mol(p+) (kg^{-1}), organic carbon 2.05 g kg^{-1} and available nitrogen (N) (70 kg ha^{-1}), Phosphorus (P) (9.14), Potassium (K) 110.13 kg ha^{-1} were, Sulphur (S) (8.14 kg ha^{-1}) and Zinc (Zn) (0.36 mg kg^{-1}), Boron (B) (0.34 mg kg^{-1}), respectively. There were eleven treatments viz., T1, Control, T2. Recommended NPK, T3 Reco. NPK+ S + Zn + B, T4 50% N + Reco. P + K + S + Zn + B + 50% N through FYM, T5 50%N + Reco. P + K + S + Zn + B + 50% N through VC, T6 75% N + Reco. P+ K +S +Zn + B+25% N through FYM, T7 75% N + Reco. P +K +S +Zn +B+25% N through VC, T8 50% N+ Reco. P+ K +S +Zn + B + 50% N through

FYM +Azot +PSB, T9 50% N + Reco. P +K +S +Zn +B+ 50% N through VC + Azot + PSB,T1075%N+Reco.P +K +S +Zn+ B+ 25% N through FYM +Azto +PSB, T11 75% N + Reco. P +K +S, Zn + B+ 25% N through VC + Azot +PSB. Each treatment was replicated thrice in a randomized block design. The recommended P, K, S, Zn and B doses, based on initial soil test, were 70.05 kg ha-1, 9.14 kg ha^{-1}, 110.13 kg ha^{-1}, 8.14 kg ha^{-1}, 0.36mg kg^{-1} and 0.34mg kg^{-1}, kg ha^{-1},maize and wheat. The sources of N through FYM and VC were incorporated treatment. (Sowing time) in the soil sowing time of maize and wheat during kharif and rabi season since 2015-16. Treatments T8, T9, T10 and T11 involved inoculation by Azotobacter and PSB culture (@ 5g kg-1 seed). Maize- wheat varieties used were Vivak Maize-25 and PBW-175 respectively, maize in general was sown on the set of monsoon (third week of July) as rainfed crop during kharif and wheat in the to fourth week of October as irrigation crop during rabi. The maturity and yield data were recorded after harvested at maturity and yield data were recorded after threshing. Soil samples from 0-15 cm depth were collected after harvest of maize in the 2th cropping year (2015-16 and 2017) and were analyzed for available N by alkaline permanganate method (Subbiah and Asija, 1956), available P (Olsen *et al.,* 1954) and available K (ammonium acetate extract).All observations were recorded for both the crops and soil properties were analyzed statistically.

1. Grain yield (kg ha^{-1}) =

$$\frac{\text{Yield obtained from net plot (kg)} \times 10{,}000}{\text{Area of net plot}}$$

2. Nutrient uptake (kg ha^{-1}) =

$$\frac{\text{Nutrient content (\%) x dry matter accumulation (kg ha}^{-1}\text{)}}{100}$$

Results and Discussion

The highest grain and straw yield of maize during 2015-16 was recorded in T_9(28.51) to lowest in T_1 (17.12) and T_9 (87.90) and lowest in T_1 (77.79).The higher yield under T_9 might be due to faster mineralization of VC and beneficial effects of Azotobacter and PSB application for seed treatment might be due to balanced addition of NPK, N, P, K, S, Zn, B under T_2(24.23) and T_3(25.63) and integrated effect of organic, inorganic and biofertilizer which enhanced nutrients availability and resulted improvement grain yield in T_5(26.54) and T_8(27.87). These observations are in line with those reported by Khandre *et al.,* 2015. Beneficial effects of Azotobacter and PSB application in wheat and have been reported by Singh and Prasad 2011, Madhu *et al.,* 2012 also obtained similar observation. However low yield in T_1 could be due to scanty availability of nutrients which resulted lead to lower yield in both years

The grain and straw yield of wheat found significantly highest in T_9 (19.90) to lowest in T_1 (8.03) and T_9 (37.95) to lowest in T_1 (18.62). It might be due to speedy mineralization of vermicompost and potential role of azotobacter and PSB. Whereas lowest grain yield in T1(8.03) could be due to less availability of nutrients. Khandare *et al.,* 2015 reported similar increases in grain yield due to Azotobacter and PSB application in combination with organic and inorganic and might be due to balanced addition of NPK and integrated uses of organic, inorganic and biofertilizers which influenced the availability of nutrients resulted in continuous improvement in grain yield of wheat. These observations are similar to those reported by Thakur *et al.,* (2011).

The highest uptake of N in grain and straw uptake of maize was found in T_9 (49.95) to lowest in T_1 (22.05) and straw of maize was

observed in T_9 (51.20) and lowest in T_1 (23.23) it might be due to balanced addition of NPK, N, P, K, S, Zn, B and combined uses of organics, inorganics and biofertilizers which directly add the nutrient and solubilized native form of nutrient. These observations were supported by Thangasamy *et al.,* (2017) and Mishra *et al.,* (2008) while studying N uptake in maize-wheat cropping system. However, N uptake under treatment T_3, T_4, T_5, T_7, T_8 and T_{11} were observed at par to each other. It may be due to poor mineralization of N in soil resulted low uptake. These findings supported by Thangasamy *et al.,* (2017). The highest total uptake of N in grain plus straw of maize was recorded in T_9(101.15) to lowest in T_1(45.28). The highest to uptake of total N in grain plus straw might be due to combined addition of organic (VC) inorganic and biofertilizer which contributes nitrogen as well as solubilized native form of nutrient from soil. However, lowest uptake of N in grain plus straw may be due to scanty amount of N in the treatment (Chaterjee *et al.,* 2017).

The highest N uptake in grain yield of wheat was obtained in T_9(17.82) to lowest in T_1(8.99) and The highest total N uptake in grain plus straw of wheat was found in T_9(51.02) and lowest in T_1(21.39). The highest total N uptake in grain plus straw might be due to integrated addition of organic, inorganic and biofertilizers which enhanced N availability in soil other by increased N uptake. Similar finding was also reported by Biswas *et al.,* (2017).

The highest P uptake in grain yield of maize was observed in T_9 (12.93) to lowest in T_1(5.19) and The highest P uptake in straw yield of maize has been observed in T_9(17.30) to lowest in T_1(12.89). The total P uptake in grain plus straw yield of maize had been observed highest in T_9(30.23) to lowest in T1(18.08). The highest P uptake in grain plus straw in T_9 due to combined addition of organic, inorganic and biofertilizer including VC and PSB which directly add the same nutrient as well as influenced its availability by solubilizing native form in soils thereby enhanced P uptake. These results support the observation of Thangasamy *et al.,* (2017).

The highest P uptake in grain yield of wheat was observed in T_9(17.82) to lowest in T_1(8.99) and The highest P uptake in straw yield of wheat was noticed in T_9(33.20) to lowest in T_1(12.40) The highest P uptake in grain plus straw in wheat was recorded in T_9(51.02) to lowest in T_1(21.39). The highest P uptake in grain plus straw in T_9(51.02) might be due to combined addition of organic, inorganic and biofertilizers including Azotobacter, PSB which directly adds and influenced its availability thereby resulted increased uptake. Whereas, lowest P uptake in T_1(21.39) can be due to its low availability, thereby decreased its uptake. These observations are in agreement with those reported by Thangasamy *et al.,* (2017), Chesti *et al.,* (2013).

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The highest P uptake in grain yield of wheat was observed in T_9(17.82) to lowest in T_1(8.99) and The highest P uptake in straw

yield of wheat was noticed in T_9(33.20) to lowest in T_1(12.40) The highest P uptake in grain plus straw in wheat was recorded in T_9(51.02) to lowest in T_1(21.39).

The highest P uptake in grain plus straw in T_9(51.02) might be due to combined addition of organic, inorganic and biofertilizers including Azotobacter, PSB which directly adds and influenced its availability thereby resulted increased uptake. Whereas, lowest P uptake in T_1(21.39) can be due to its low availability, thereby decreased its uptake. These observations are in agreement with those reported by Thangasamy *et al.,* 2017, Chesti *et al.,* 2013. The highest total K uptake in grain plus straw of maize was noticed in T_9 (128.80) to lowest in T_1(92.36) and the highest K uptake in grain yield of wheat was observed in T_9(55.02) and lowest in T_1(20.85).

The total K uptake in grain plus straw was highest in T_9(177.62) and lowest in T_1(74.83) The highest K uptake in grain yield of maize and wheat may be due to integrated addition of organic, inorganic and biofertilizers which influenced its availability in soil (Fig. 1–5 and Table 1–8).

Table.1 Integrated effect of inorganic, organic and biofertilizers on grain and straw yield (q ha^{-1}) after harvesting of maize crop

Sr.No	Treatments	I st year	II nd year	Overall	I st year	II nd year	Overall
		(q ha^{-1})			(q ha^{-1})		
T1	**Control**	17.12	18.25	17.69	77.79	80.86	79.33
T2	**Recommended NPK**	24.23	25.13	24.68	79.12	83.29	81.21
T3	**Reco. NPK+ S + Zn + B**	25.63	26.34	25.99	84.74	86.38	85.56
T4	**50% N + Reco. P + K + S + Zn + B + 50% N through FYM**	25.50	26.74	26.12	84.90	86.25	85.58
T5	**50% N + Reco. P + K + S + Zn + B + 50% N through VC**	26.54	27.46	27.00	85.62	88.49	87.06
T6	**75% N + Reco. P+ K +S +Zn + B+25% N through FYM**	25.50	26.74	26.12	83.58	84.38	83.98
T7	**75% N + Reco. P +K +S +Zn +B+25% N through VC**	25.99	27.29	26.64	83.44	85.24	84.34
T8	**50% N+ Reco. P+ K +S +Zn + B + 50% N through FYM +Azot +PSB**	27.87	28.66	28.27	86.33	89.03	87.68
T9	**50% N + Reco. P +K +S +Zn +B+ 50% N through VC + Azot + PSB**	28.51	29.35	28.93	87.90	89.86	88.88
T10	**75%N+Reco.P +K +S +Zn+ B+ 25% N through FYM +Azto +PSB**	27.56	28.53	28.05	85.21	85.60	86.41
T11	**75% N + Reco. P +K +S, Zn + B+ 25% N through VC + Azot +PSB**	27.16	27.47	27.32	85.95	86.92	86.44
	± S.E.(m)	0.23	0.23	0.14	0.35	0.39	0.57
	C.D. (P=0.05)	0.67	0.70	0.45	1.04	1.18	1.81

Table.2 Integrated effect of inorganic, organic and biofertilizers on grain and straw yield (q ha^{-1}) after harvesting of wheat crop

Sr.No	Treatments	I st year	II nd year	Overall	I st year	II nd year	Overall
		(q ha^{-1})			(q ha^{-1})		
T1	Control	7.31	8.03	7.67	18.62	20.29	19.46
T2	Recommended NPK	13.78	14.61	14.20	24.89	31.36	28.13
T3	Reco. NPK+ S + Zn + B	14.76	15.63	15.20	31.05	34.19	32.62
T4	50% N + Reco. P + K + S + Zn + B + 50% N through FYM	15.29	16.40	15.85	34.20	35.59	34.90
T5	50% N + Reco. P + K + S + Zn + B + 50% N through VC	16.63	17.25	17.19	37.04	36.20	36.62
T6	75% N + Reco. P+ K +S +Zn + B+25% N through FYM	14.47	15.68	15.08	37.07	34.89	35.98
T7	75% N + Reco. P +K +S +Zn +B+25% N through VC	14.87	15.96	15.42	37.95	37.01	37.48
T8	50% N+ Reco. P+ K +S +Zn + B + 50% N through FYM +Azot +PSB	17.45	18.50	17.98	37.27	38.75	38.01
T9	50% N + Reco. P +K +S +Zn +B+ 50% N through VC + Azot + PSB	19.04	19.90	19.47	38.00	40.39	39.20
T10	75%N+Reco.P +K +S +Zn+ B+ 25% N through FYM +Azto +PSB	14.24	15.38	14.63	35.50	37.43	36.47
T11	75% N + Reco. P +K +S, Zn + B+ 25% N through VC + Azot +PSB	15.02	16.23	15.63	37.37	39.84	38.61
	± S.E.(m)	0.34	0.32	0.09	1.90	0.38	1.24
	C.D. (P=0.05)	1.01	0.95	0.27	6.06	1.13	3.96

Table.3 Integrated effect of inorganic, organic and biofertilizers on nitrogen uptake (kg ha^{-1}) in grain, straw and total uptake after harvesting of maize crop

Sr.No	Treatments	Grain (I^{st} year)	Straw (I^{st} year)		Total uptake	Grain (II^{nd} year)	Straw (II^{nd} year)	Total uptake	
		(kg ha^{-1})				(kg ha^{-1})			
T1	Control	22.05	23.23	45.28	24.39	23.72	48.11	22.05	23.23
T2	Recommended NPK	33.51	23.99	57.50	35.55	26.09	61.64	33.51	23.99
T3	Reco. NPK+ S + Zn + B	41.60	32.17	73.77	43.29	33.35	76.64	41.60	32.17
T4	50% N + Reco. P + K + S + Zn + B + 50% N through FYM	45.78	39.67	85.45	48.63	40.99	89.62	45.78	39.67
T5	50% N + Reco. P + K + S + Zn + B + 50% N through VC	47.95	45.85	93.80	48.87	48.31	97.18	47.95	45.85
T6	75% N + Reco. P+ K +S +Zn + B+25% N through FYM	44.88	40.88	85.76	46.83	42.06	88.89	44.88	40.88
T7	75% N + Reco. P +K +S +Zn +B+25% N through VC	46.57	44.03	90.60	47.56	51.19	98.75	46.57	44.03
T8	50% N+ Reco. P+ K +S +Zn + B + 50% N through FYM +Azot +PSB	45.89	47.23	93.12	47.51	51.82	99.33	45.89	47.23
T9	50% N + Reco. P +K +S +Zn +B+ 50% N through VC + Azot + PSB	49.95	51.20	101.15	50.67	53.12	103.79	49.95	51.20
T10	75%N+Reco.P +K +S +Zn+ B+ 25% N through FYM +Azto +PSB	42.51	43.85	86.36	46.49	47.08	93.57	42.51	43.85
T11	75% N + Reco. P +K +S, Zn + B+ 25% N through VC + Azot +PSB	47.25	47.16	94.41	47.21	49.83	97.04	47.25	47.16
	± S.E.(m)	0.88	1.07	1.95	0.69	0.77	1.45	0.88	1.07
	C.D. (P=0.05)	2.62	3.16	5.77	2.03	2.28	4.30	2.62	3.16

Table.4 Integrated effect of inorganic, organic and biofertilizers on nitrogen uptake (kg ha^{-1}) in grain, straw and total uptake after harvesting of wheat crop

Sr.No	Treatments	Grain (I^{st} year)	Straw (I^{st} year)		Total uptake	Grain (II^{nd} year)	Straw (II^{nd} year)	Total uptake	
		(kg ha^{-1})				(kg ha^{-1})			
T1	Control	8.99	12.40	21.39	8.38	13.71	22.09	8.99	12.40
T2	Recommended NPK	14.42	23.74	38.16	13.97	25.13	39.1	14.42	23.74
T3	Reco. NPK+ S + Zn + B	15.84	25.82	41.66	15.57	27.19	42.76	15.84	25.82
T4	50% N + Reco. P + K + S + Zn + B + 50% N through FYM	17.16	27.05	44.21	17.65	28.92	46.57	17.16	27.05
T5	50% N + Reco. P + K + S + Zn + B + 50% N through VC	16.30	29.54	45.84	18.09	30.82	48.91	16.30	29.54
T6	75% N + Reco. P+ K +S +Zn + B+25% N through FYM	15.70	24.02	39.72	16.11	26.95	43.06	15.70	24.02
T7	75% N + Reco. P +K +S +Zn +B+25% N through VC	17.40	26.02	43.42	17.42	27.82	45.24	17.40	26.02
T8	50% N+ Reco. P+ K +S +Zn + B + 50% N through FYM +Azot +PSB	17.82	30.69	49.94	18.36	32.87	51.23	17.82	30.69
T9	50% N + Reco. P +K +S +Zn +B+ 50% N through VC + Azot + PSB	19.25	33.20	52.45	17.74	34.83	52.57	19.25	33.20
T10	75%N+Reco.P +K +S +Zn+ B+ 25% N through FYM +Azto +PSB	17.35	24.65	42.00	16.66	26.76	43.42	17.35	24.65
T11	75% N + Reco. P +K +S, Zn + B+ 25% N through VC + Azot +PSB	17.35	24.65	42.00	16.66	26.76	43.42	17.35	24.65
	± S.E.(m)	0.23	0.71	0.94	0.77	0.59	1.37	0.23	0.71
	C.D. (P=0.05)	16.82	25.91	42.73	17.51	28.07	45.58	16.82	25.91

Table.5 Integrated effect of inorganic, organic and biofertilizers on phosphorus uptake (kg ha^{-1}) in grain, straw and total uptake after harvesting of maize

Sr.No	Treatments	Grain (I^{st} year)	Straw (I^{st} year)		Total uptake	Grain (II^{nd} year)	Straw (II^{nd} year)	Total uptake	
		(kg ha^{-1})				(kg ha^{-1})			
T1	Control	5.19	12.89	18.08	5.96	13.75	19.71	5.19	12.89
T2	Recommended NPK	7.84	13.27	21.11	8.80	14.27	23.07	7.84	13.27
T3	Reco. NPK+ S + Zn + B	8.12	16.90	25.02	9.48	17.42	26.90	8.12	16.90
T4	50% N + Reco. P + K + S + Zn + B + 50% N through FYM	10.36	15.91	26.27	11.54	16.30	27.84	10.36	15.91
T5	50% N + Reco. P + K + S + Zn + B + 50% N through VC	12.23	16.09	28.32	12.67	16.10	28.77	12.23	16.09
T6	75% N + Reco. P+ K +S +Zn + B+25% N through FYM	10.57	16.49	27.06	11.56	17.19	28.75	10.57	16.49
T7	75% N + Reco. P +K +S +Zn +B+25% N through VC	10.21	17.19	27.40	11.22	18.87	30.09	10.21	17.19
T8	50% N+ Reco. P+ K +S +Zn + B + 50% N through FYM +Azot +PSB	11.71	16.19	27.90	13.12	17.67	30.79	11.71	16.19
T9	50% N + Reco. P +K +S +Zn +B+ 50% N through VC + Azot + PSB	12.93	17.30	30.23	12.52	18.43	30.95	12.93	17.30
T10	75%N+Reco.P +K +S +Zn+ B+ 25% N through FYM +Azto +PSB	12.31	15.40	27.71	12.56	16.07	28.63	12.31	15.40
T11	75% N + Reco. P +K +S, Zn + B+ 25% N through VC + Azot +PSB	11.59	12.89	24.48	11.82	13.75	25.57	11.59	12.89
	± S.E.(m)	0.24	1.13	1.35	0.28	0.83	1.16	0.24	1.13
	C.D. (P=0.05)	0.71	0.38	1.09	0.81	0.30	1.11	0.71	0.38

Table.6 Integrated effect of inorganic, organic and biofertilizers on phosphorus uptake (kg ha^{-1}) in grain, straw and total uptake after harvesting of wheat

Sr.No	Treatments	Grain (I^{st} year)	Straw (I^{st} year)		Total uptake	Grain (II^{nd} year)	Straw (II^{nd} year)	Total uptake	
		(kg ha^{-1})				(kg ha^{-1})			
T1	Control	8.99	12.40	21.39	8.38	13.71	22.09	8.99	12.40
T2	Recommended NPK	14.42	23.74	38.16	13.97	25.13	39.1	14.42	23.74
T3	Reco. NPK+ S + Zn + B	15.84	25.82	41.66	15.57	27.19	42.76	15.84	25.82
T4	50% N + Reco. P + K + S + Zn + B + 50% N through FYM	17.16	27.05	44.21	17.65	28.92	46.57	17.16	27.05
T5	50% N + Reco. P + K + S + Zn + B + 50% N through VC	16.30	29.54	45.84	18.09	30.82	48.91	16.30	29.54
T6	75% N + Reco. P+ K +S +Zn + B+25% N through FYM	15.70	24.02	39.72	16.11	26.95	43.06	15.70	24.02
T7	75% N + Reco. P +K +S +Zn +B+25% N through VC	17.40	26.02	43.42	17.42	27.82	45.24	17.40	26.02
T8	50% N+ Reco. P+ K +S +Zn + B + 50% N through FYM +Azot +PSB	19.25	30.69	49.94	18.36	32.87	51.23	19.25	30.69
T9	50% N + Reco. P +K +S +Zn +B+ 50% N through VC + Azot + PSB	17.82	33.20	51.02	17.74	34.83	52.57	17.82	33.20
T10	75%N+Reco.P +K +S +Zn+ B+ 25% N through FYM +Azto +PSB	17.35	24.65	42.00	16.66	26.76	43.42	17.35	24.65
T11	75% N + Reco. P +K +S, Zn + B+ 25% N through VC + Azot +PSB	17.35	24.65	42.00	16.66	26.76	43.42	17.35	24.65
	± S.E.(m)	0.23	0.71	0.94	0.77	0.59	1.37	0.23	0.71
	C.D. (P=0.05)	16.82	25.91	42.73	17.51	28.07	45.58	16.82	25.91

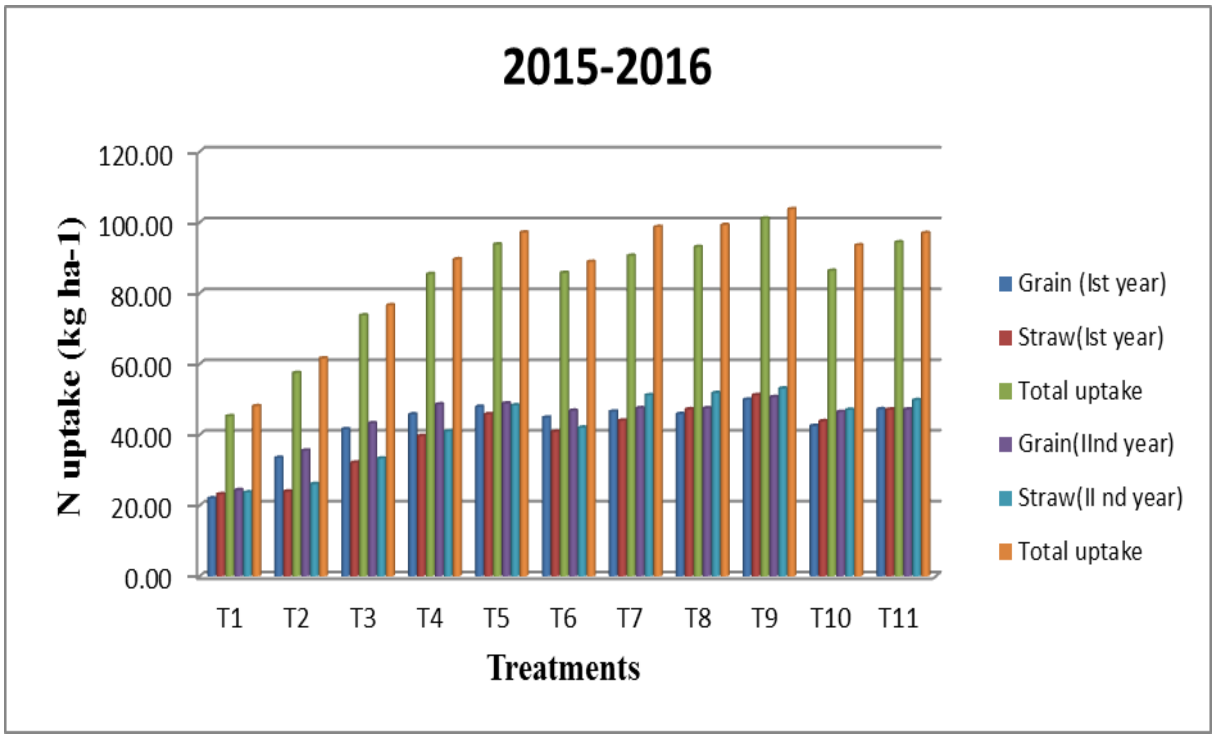
Table.7 Integrated effect of inorganic, organic and biofertilizers on potassium uptake (kg ha-1) in grain, straw and total uptake after harvesting of maize

Sr.No	Treatments	Grain (I^{st} year)	Straw (I^{st} year)		Total uptake	Grain (II^{nd} year)	Straw (II^{nd} year)		Total uptake
		(kg ha^{-1})				(kg ha^{-1})			
T1	Control	4.72	87.64	92.36	4.93	90.03	94.96	4.72	87.64
T2	Recommended NPK	6.92	95.20	102.12	7.89	93.98	101.87	6.92	95.20
T3	Reco. NPK+ S + Zn + B	8.37	97.99	106.36	10.03	99.91	109.94	8.37	97.99
T4	50% N + Reco. P + K + S + Zn + B + 50% N through FYM	11.55	99.03	110.58	11.97	100.87	112.84	11.55	99.03
T5	50% N + Reco. P + K + S + Zn + B + 50% N through VC	12.44	103.31	115.75	12.39	106.64	119.03	12.44	103.31
T6	75% N + Reco. P+ K +S +Zn + B+25% N through FYM	12.21	100.12	112.33	12.07	10.4.64	116.71	12.21	100.12
T7	75% N + Reco. P +K +S +Zn +B+25% N through VC	12.20	105.82	118.02	12.52	109.71	122.23	12.20	105.82
T8	50% N+ Reco. P+ K +S +Zn + B + 50% N through FYM +Azot +PSB	13.34	108.41	121.75	12.97	110.53	123.50	13.34	108.41
T9	50% N + Reco. P +K +S +Zn +B+ 50% N through VC + Azot + PSB	14.26	114.54	128.8	14.99	115.13	130.12	14.26	114.54
T10	75%N+Reco.P +K +S +Zn+ B+ 25% N through FYM +Azto +PSB	12.40	107.72	120.12	12.86	108.36	121.22	12.40	107.72
T11	75% N + Reco. P +K +S, Zn + B+ 25% N through VC + Azot +PSB	12.87	108.52	121.39	13.42	109.57	122.99	12.87	108.52
	± S.E.(m)	0.32	1.78	2.09	0.49	1.81	2.30	0.32	1.78
	C.D. (P=0.05)	0.95	5.26	6.21	1.02	5.38	6.40	0.95	5.26

Table.8 Integrated effect of inorganic, organic and biofertilizers on potassium uptake (kg ha-1) in grain, straw and total uptake after harvesting of wheat

Sr. No	Treatments	Grain (I st year)	Straw (I st year)	Total uptake	Grain (II nd year)	Straw (II nd year)	Total uptake	
		(kg ha-1)			(kg ha-1)			
T1	Control	20.85	53.98	74.83	23.04	58.02	81.06	20.85	53.98
T2	Recommended NPK	39.25	88.31	127.56	42.23	90.09	132.32	39.25	88.31
T3	Reco. NPK+ S + Zn + B	42.15	99.14	141.29	44.99	98.93	143.92	42.15	99.14
T4	50% N + Reco. P + K + S + Zn + B + 50% N through FYM	47.57	112.58	160.15	50.79	108.92	159.71	47.57	112.58
T5	50% N + Reco. P + K + S + Zn + B + 50% N through VC	49.57	119.68	169.25	52.03	118.27	170.30	49.57	119.68
T6	75% N + Reco. P+ K +S +Zn + B+25% N through FYM	41.92	104.15	146.07	47.80	104.56	152.36	41.92	104.15
T7	75% N + Reco. P +K +S +Zn +B+25% N through VC	45.6	118.6	164.2	46.86	113.12	159.98	45.6	118.6
T8	50% N+ Reco. P+ K +S +Zn + B + 50% N through FYM +Azot +PSB	54.3	116.97	171.27	57.99	117.39	175.38	54.3	116.97
T9	50% N + Reco. P +K +S +Zn +B+ 50% N through VC + Azot + PSB	55.02	122.6	177.62	60.74	126.81	187.55	55.02	122.6
T10	75%N+Reco.P +K +S +Zn+ B+ 25% N through FYM +Azto +PSB	42.35	104.26	146.61	45.17	110.56	155.73	42.35	104.26
T11	75% N + Reco. P +K +S, Zn + B+ 25% N through VC + Azot +PSB	43.43	110.11	153.54	48.25	108.20	156.45	43.43	110.11
	± S.E.(m)	1.22	1.93	3.16	0.97	1.73	2.69	1.22	1.93
	C.D. (P=0.05)	3.61	5.76	9.37	2.87	5.13	8.00	3.61	5.76

Fig.1 Integrated effect of inorganic, organic and biofertilizers on N uptake (kg ha^{-1}) of maize-wheat cropping system during 2015-16 and 2016-17



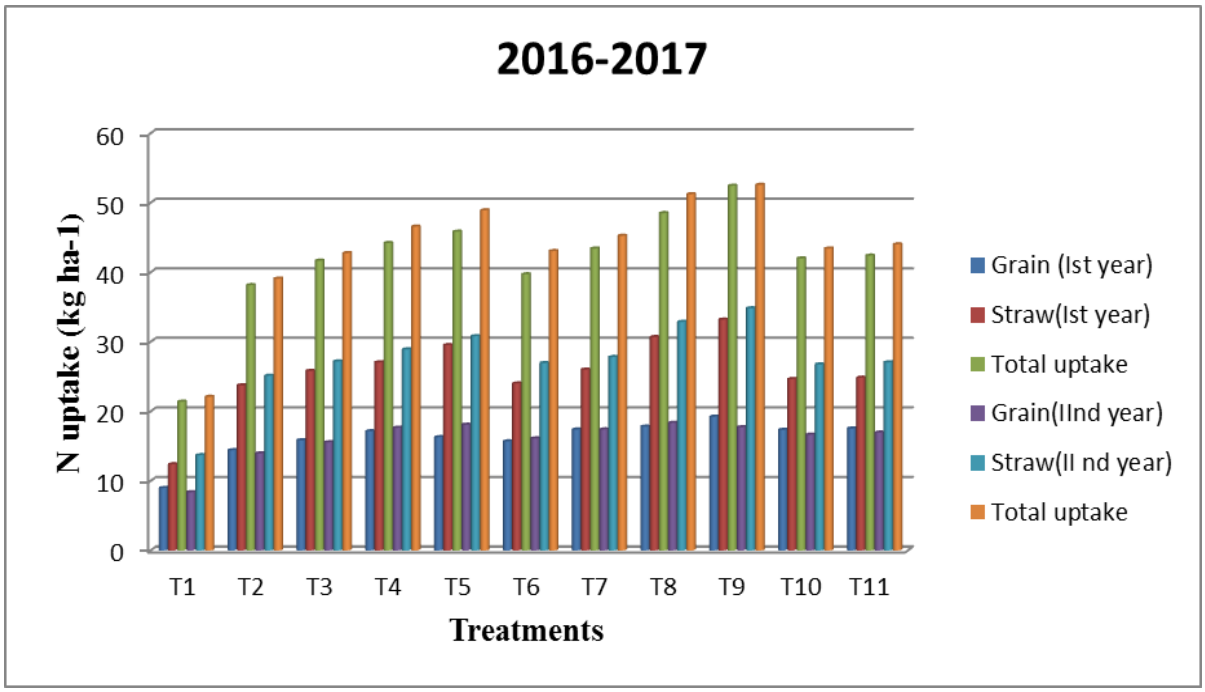
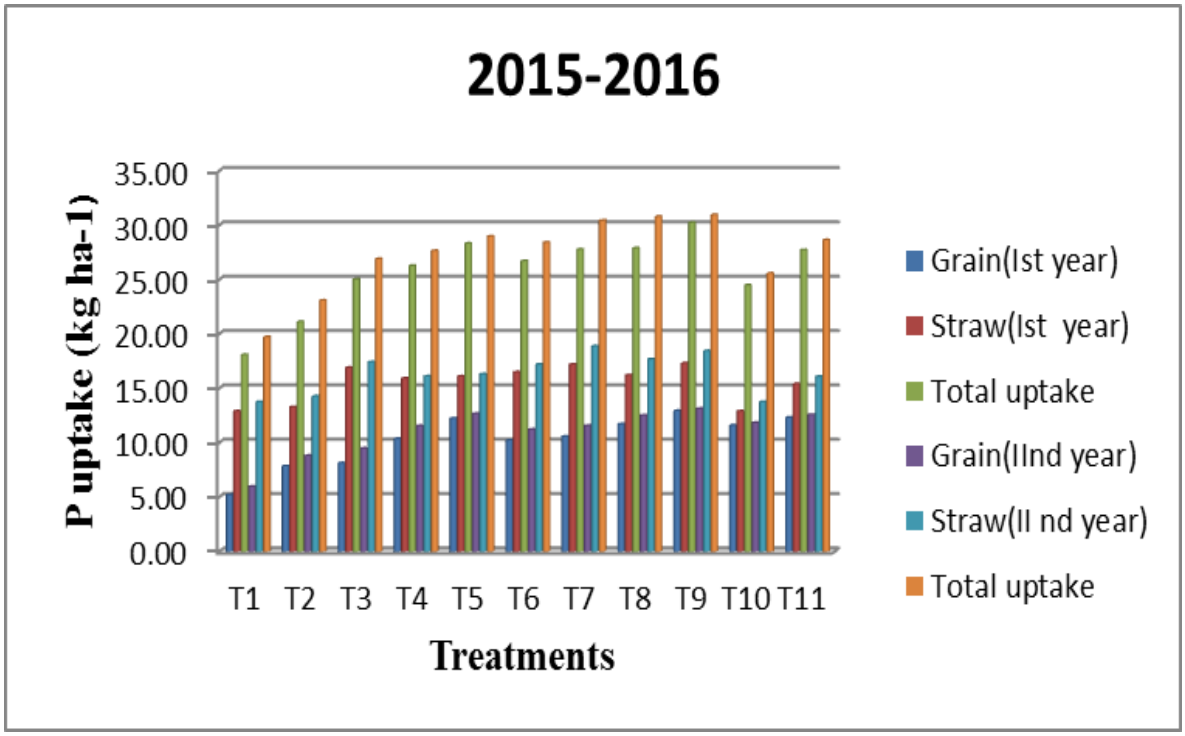


Fig.2 Integrated effect of inorganic, organic and biofertilizers on P uptake (kg ha^{-1}) of maize-wheat cropping system during 2015-16 and 2016-17



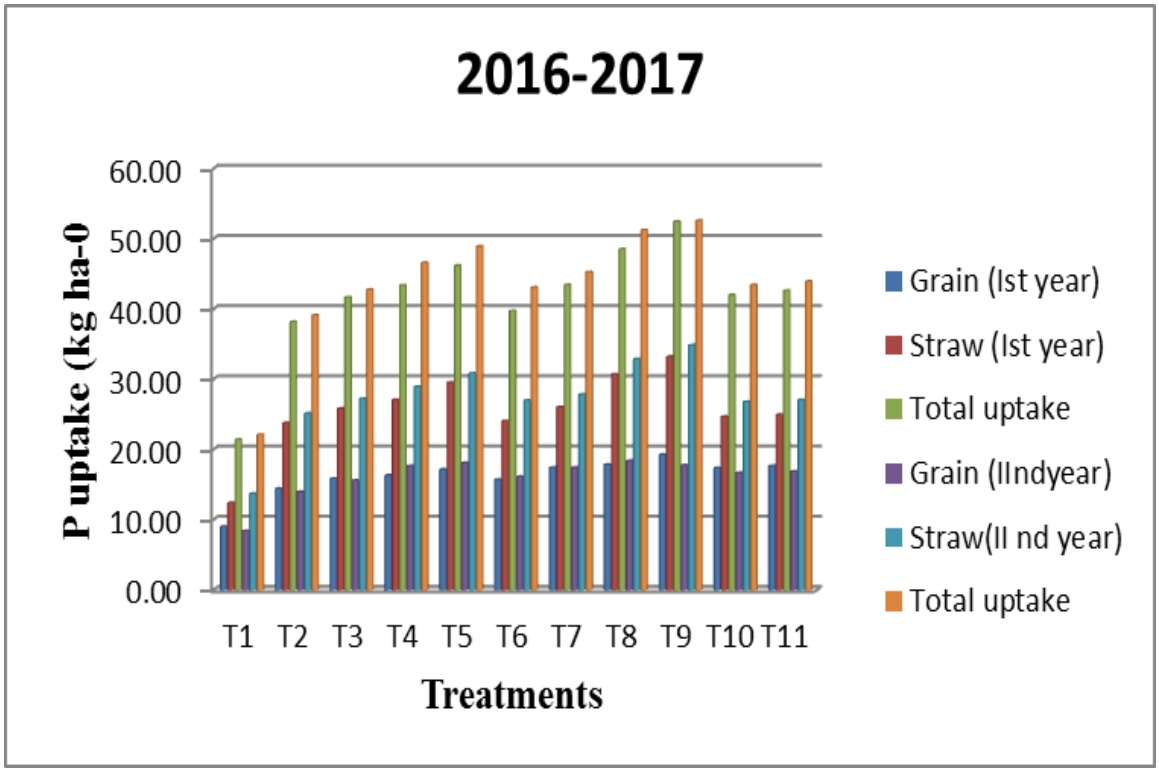
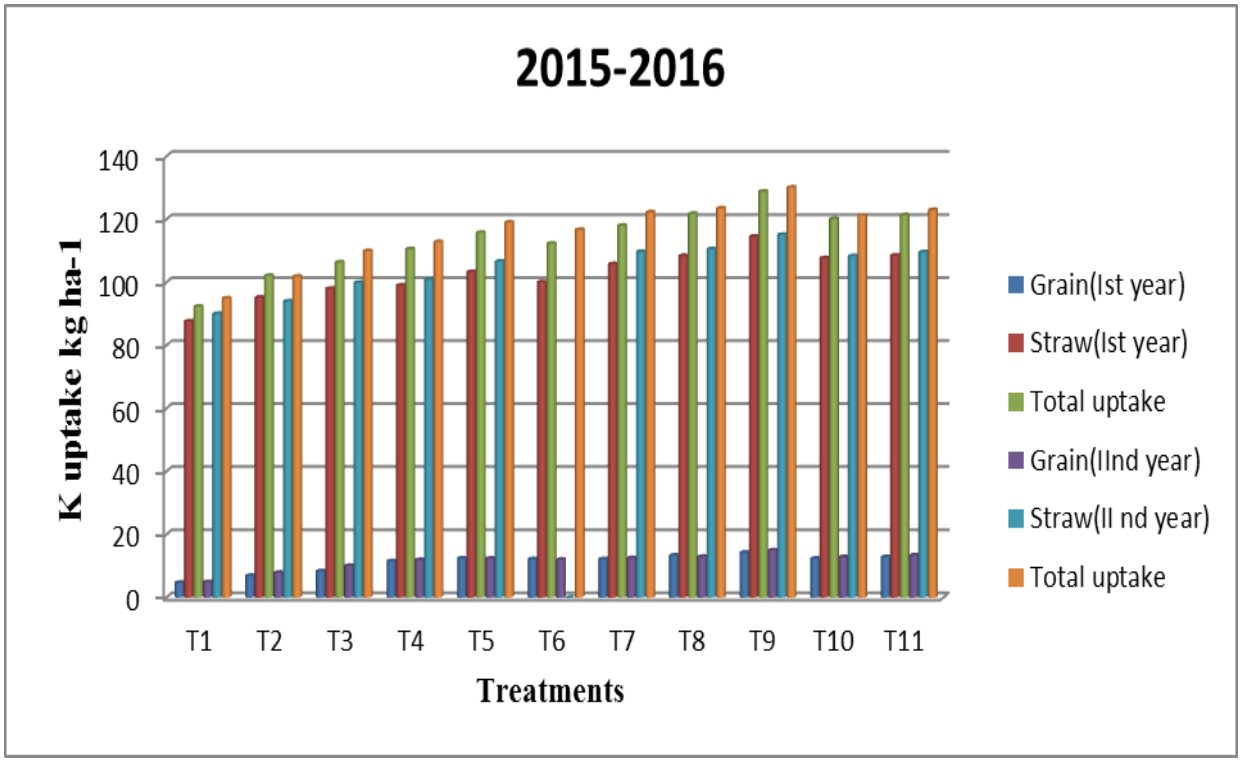


Fig.3 Integrated effect of inorganic, organic and biofertilizers on K uptake (kg ha^{-1}) of maize-wheat cropping system during 2015-16 and 2016-17



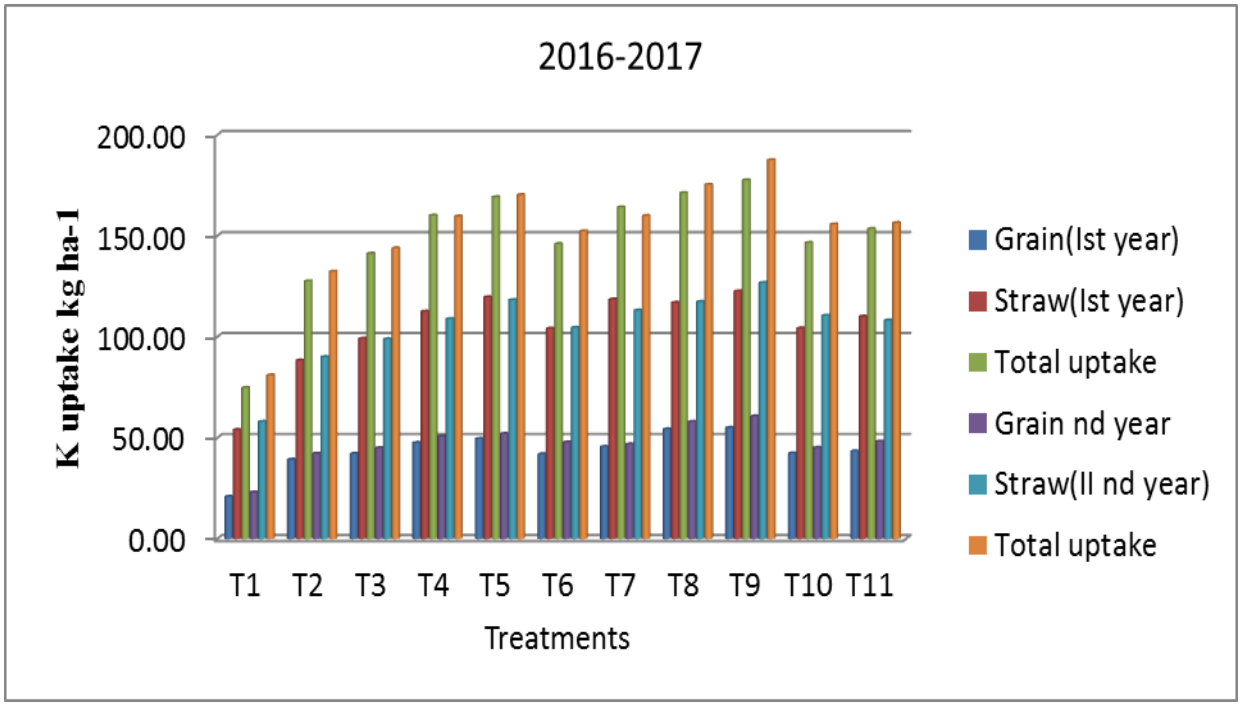
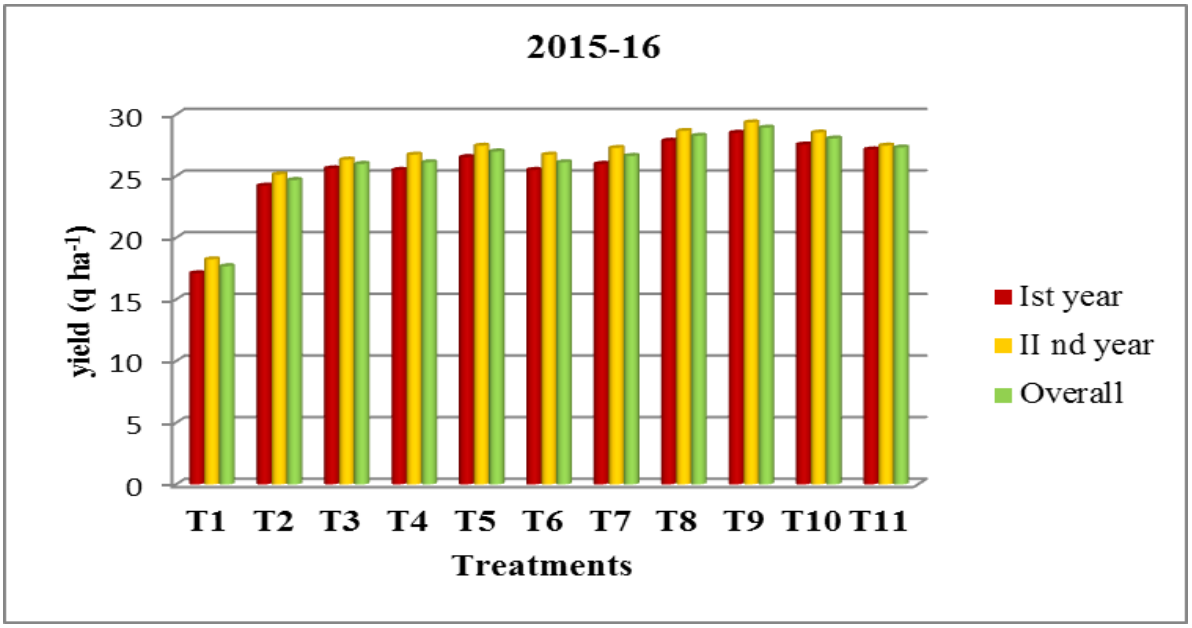


Fig.4 Integrated effect of inorganic, organic and biofertilizers on grain and straw yield (q ha^{-1}) of maize crop during 2015-16



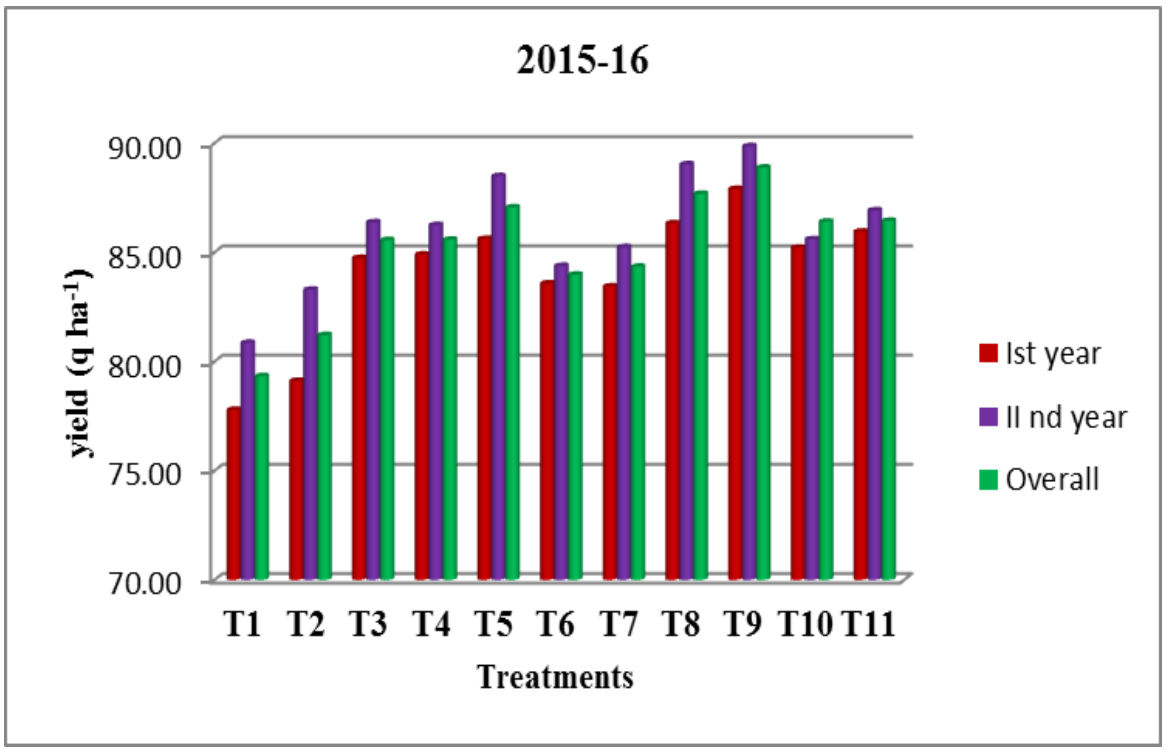
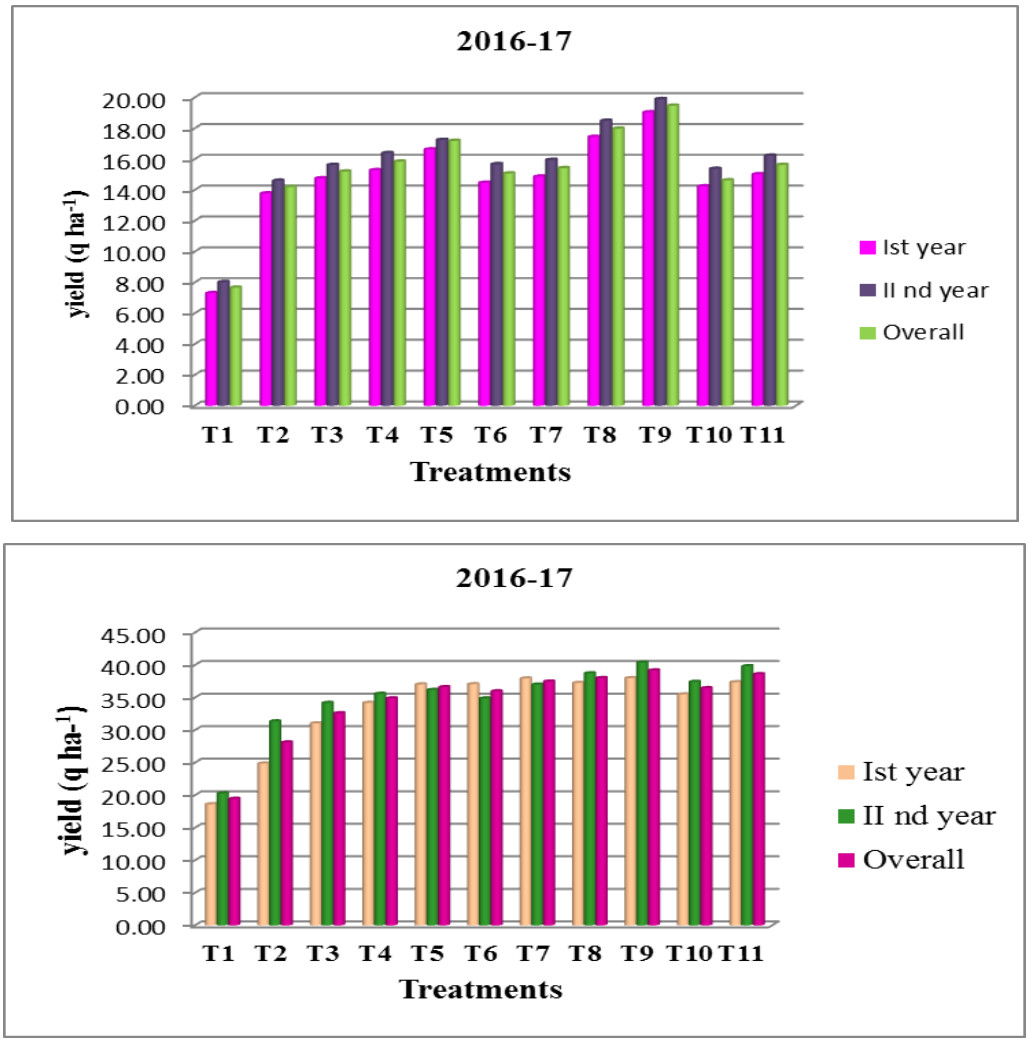


Fig.5 Integrated effect of inorganic, organic and biofertilizers on grain and straw yield (q ha-1) of wheat crop during 2016-17



Whereas, lowest K uptake in T_1 (20.85) might be due to scanty availability of K thereby results decreased its uptake, could be due to balanced application of N P K, N, P, K, S, Zn, B and mixed uses of organic, inorganic and biofertilizers which directly influenced the availability of K in soils thereby increased K uptake in all the treatments. These results are line with those reported by Chesti *et al.*, (2013), Khandare *et al.*, (2015) and Thangasamy *et al.*, (2017).

In conclusion, the result of the study concluded with respect to the grain and straw yield of maize influenced significantly due to integration of organic, inorganic and biofertilizers. The values of nutrients uptake viz, N, P, K, S, Zn, B observed highest under T_9 consisting integrated uses of organic, inorganic and biofertilizers.

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