International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
www.chemijournal.com
IJCS 2020; 8(4): 3237-3239

Received: 26-05-2020
Accepted: 27-06-2020

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Assessing nutrient requirement of wheat under maize-wheat cropping sequence

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DOI: https://doi.org/10.22271/chemi.2020.v8.i4an.10153

Abstract
In order to assess the nutrient requirement of wheat after grain maize was conducted at Agricultural Research Station, Niphad, Dist. Nashik, Maharashtra during 2014-15 to 2016-17. During *kharif* season, maize (cv. Rajeshree) for grain purpose was sown by applying of recommended dose of fertilizers (120:60:40 N:P_2O_5:K_2O kg ha^{-1}). In *rabi* season wheat crop was sown with five treatments *viz.* absolute control, recommended dose of fertilizers (120:60:40 N:P_2O_5:K_2O kg ha^{-1}+ FYM 10 t ha^{-1}), fertilizer application as per soil test basis, 125 per cent of recommended dose of fertilizers and 150 per cent of recommended dose of fertilizers. The pooled results of three years experiment revealed that application of 150 per cent of recommended dose of fertilizers to wheat crop produced significantly higher grain (40.28 q ha^{-1}) and straw (55.50 q ha^{-1}) yields over absolute control. It was at par with the treatment application of 125 per cent of recommended dose of fertilizers (38.27 q ha^{-1}) and fertilizer application as per soil test basis (37.44 q ha^{-1}). The soil available major nutrients viz. nitrogen, phosphorus and potassium, after harvest of wheat, were observed higher in the treatment of 150 per cent of recommended dose of fertilizers compared to initial status of the soil.

Keywords: Maize, wheat, nutrient requirement

Introduction
As maize has wide adaptability and compatibility under diverse soil and climatic conditions, it is cultivated in sequence with different crops under various agro-ecologies of the country. Hence, it is considered as one of the potential driver of crop diversification under different situation. Among different maize based cropping systems, maize-wheat ranks 1st having 1.8 m ha area mainly concentrated in rainfed ecologies. Maize-wheat is the 3rd most important cropping systems after rice-wheat and rice-rice that contributes about 3 per cent in the national food basket. As it is universally known that maize is the heavy feeder crop, the nutrient management of such crop is very essential under sole cropping or in cropping system. As a result of its negligence, most of the productive soils are becoming unproductive. Imbalanced fertilization is one of the important factor limiting crop yields. Problem is more severe in acid soils which are under continuous cropping (Prasad *et al*., 2010) [6] Hence, to assess the nutrient requirement of wheat after grain maize the present experiment was conducted.

Materials and Methods
Three cycles of maize-wheat cropping sequence were conducted with fertilizer management at Agricultural Research Station, Niphad, Dist. Nasik (MS) during 2014-15 to 2016-17. Maize was taken as a general crop in *kharif* season and for subsequent wheat crop in *rabi*, five treatments as absolute control, recommended dose of fertilizers, fertilizer application as per soil test basis, 125 per cent of RDF and 150 per cent of RDF were given. The experiment was laid out in randomised block design with four replications. The soil of the experimental site was clayey in texture having pH 8.24, EC 0.41 dSm^{-1}, medium in organic carbon (0.51%), medium in nitrogen (278 kg ha^{-1}), medium in phosphorous (18.17 kg ha^{-1}) and high in potassium (471 kg ha^{-1}). Soil samples before and after harvest of each crop were collected and analyzed for major and micronutrients using standard procedures.

Results and Discussion

The pooled results from Table 1 revealed that the grain and straw yields were influenced significantly due to different treatments of fertilizer. Fertilizer application @ 150 per cent (180:90:60 N:P_2O_5:K_2O kg ha^{-1}) of the recommended dose of fertilizers produced significantly higher grain (40.28 q ha^{-1}) and straw (55.50 q ha^{-1}) yields over absolute control (zero fertilizers) and recommended dose of fertilizers. It was at par with the treatments of fertilizer application as per soil test (180:60:20 N:P_2O_5:K_2O kg ha^{-1}) and 125 per cent of RDF (150:75:50 N: P_2O_5:K_2O kg ha^{-1}). Sharma *et al* (2014) [7] reported the results on effect of three decade long term application of chemical fertilizers and amendments on the yield of continuous maize-wheat crop rotation in an acid alfisol at Palampur revealed that continuous omission of essential nutrients in a maize-wheat sequence resulted in an appreciable decline in the grain yield of maize and wheat crops. A remarkable reduction in crop yield was noticed in plots where nitrogen was applied alone. Use of recommended level of N alone through urea had deleterious effect on crop productivity. The continuous exhaustion of native pools of K in 100 per cent NP treated plots appreciably reduced percent grain yield. Application of farmyard manure (FYM) and lime along with NPK fertilizers increased the crop yield.

The integrated use of optimal dose of NPK and FYM give better and more sustainable yields. Hadda and Arora (2006) [3] reported that significant increase in grain yield of wheat was observed with the application of different soil and nutrient management practices over the farmers' practice with a maximum of 34 per cent. Soil moisture storage increased by 12, 30, 35 and 45 per cent with shallow tillage, deep tillage, recommended dose of fertilizers (RDF, 75%) + FYM and raised-bed sowing, respectively compared with the farmers' practice. Raised-bed sowing, RDF (100%), RDF (75%) + FYM and deep tillage showed an increase of 52, 55, 57 and 37 per cent, respectively in height of maize plant over the farmers' practice at 60 days after sowing.

The soil analysis after harvest of wheat (Table 2) reveled that, application of fertilizers @ 150 per cent of RDF (T_5) significantly improved the N, P and K content of the soil. Whereas, soil available nutrients in other treatments were also improved over initial soil status due to different levels of fertilizer application except absolute control. Naresh *et al* (2014) [4] observed that there was no significant increase in yield of maize beyond 120 kg N ha^{-1}. Sole maize-wheat rotation showed a decline in soil organic carbon by 3.7 per cent, while black gram and cowpea intercropping with maize in paired rows (2:2 row ratio) followed by wheat had increased contents of per cent organic carbon in soil as 0.63 and 0.67, respectively, as compared to initial values of 0.54 per cent. Plots treated with intercrops/farm yard manure (FYM) during the rainy season sustained the wheat yield while the control plot showed a decline in wheat yield by 4-9 per cent. Prasad *et al* (2010) [6] reported that maximum N, P and K uptake values were recorded when 50 per cent N was substituted by FYM in maize (114.6, 23.9 and 125.5 kg ha^{-1}) and wheat (99.7, 18.1 and 89.8 kg ha^{-1}) and maize-wheat system (214.3, 42.0 and 215.3 kg ha^{-1}) followed by 25% N through FYM and remaining through inorganic source and minimum in control. The productivity, nutrient uptake and per cent response increased with the increase in the fertilizer level but the reverse trend was noted in case of agronomic efficiency and apparent N recovery per cent.

The data on nutrient uptake of the wheat (Table 3) revealed the significant difference in major nutrient uptake was recorded due to different fertilizer treatments. The application of 150 per cent recommended dose of fertilizer significantly improved nitrogen (145.36 kg ha^{-1}), phosphorus (38.45 kg ha^{-1}) and potassium (228.55 kg ha^{-1}). It might be due to balanced and fair supply of the essential elements which might have facilitated utilization of assimilates towards synthesis of high molecular weight compounds like amino acids, proteins and nucleic acids etc. thereby maintaining a continuous demand for carbon assimilation. Favorable effect of fertilizer application on nitrogen in wheat has also been reported by Behera and Singh (2009) [1], Dwivedi *et al*., (2017) [2]. The economics of wheat (Table 4) was influenced due to different fertilizer treatments. Significantly higher gross returns (Rs.85213 ha^{-1}) was observed in the treatment where 150 per cent of RDF was applied which was at par with 125 per cent of RDF (Rs. 80837) and AST (Rs. 79282).

However the higher B:C ratio (1:2.45) was observed in the control treatment since no fertilizers were applied to it. This was followed by the treatment application of 125 per cent fertilizers (T_4) (1:2.42) and 150 per cent of the RDF (T_5) (1:2.35). Sharma *et al*. (2015) [8] reported that application of recommended dose of NPK resulted in significantly higher grain yield of maize and wheat, maize equivalent yield, gross return and net return over rest of the treatments. Recommended NPK resulted in 85 per cent and 53 per cent higher maize grain equivalent yield and Rs 30150 and Rs 24626 more net return over control and recommended N, respectively. The response in terms of kg grain per kg of nutrient applied was higher for applied phosphorus (20.85 kg maize grain equivalent) followed by potash (19.19) and nitrogen (5.69).

Table 1: Grain, straw yields, thousand grain weight of wheat

Treatment	2014-15		2015-16		2016-17		Mean	
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
	(q ha^{-1})							
1. Control	21.67	29.28	20.19	32.39	14.33	20.94	18.73	27.54
2. GRDF	29.88	41.56	28.89	42.64	36.10	47.68	31.62	43.96
3. AST	35.82	51.70	35.57	52.62	40.94	56.29	37.44	53.54
4. 125% of RDF	36.96	50.23	36.01	51.56	41.85	55.14	38.27	52.31
5. 150% of RDF	37.19	52.14	39.61	57.28	44.03	57.09	40.28	55.50
SE±	1.71	1.86	2.55	2.83	1.86	2.04	0.94	1.54
CD at 5%	5.27	5.75	7.86	8.75	5.74	6.28	2.91	4.75

Table 2: Soil analysis data after harvest of wheat

Treatment	pH	EC	N	P	K
	-	(dSm^{-1})	(kg ha^{-1})		
Initial	**7.69**	**0.44**	**152.35**	**21.77**	**452**
1. Control	7.67	0.53	127.41	17.84	375
2. GRDF	7.74	0.51	162.61	23.44	427
3. AST	7.74	0.44	177.78	28.66	465
4. 125% of RDF	7.75	0.43	197.72	32.86	490
5. 150% of RDF	7.74	0.44	202.06	34.65	487
SE±	-	-	6.23	1.15	10.21
CD at5%	-	-	19.22	3.57	31.48

Table 3: Uptake of nutrients by wheat (Pooled mean of 3 years)

Treatments	N (kg ha^{-1})	P (kg ha^{-1})	K (kg ha^{-1})
1. Control	70.24	18.36	196.54
2. GRDF	135.98	33.26	265.14
3. AST	128.20	28.51	210.20
4. 125% of RDF	142.56	33.65	226.54
5. 150% of RDF	145.36	38.45	228.55
SE ±	5.83	1.72	6.18
CD 5%	17.99	5.26	19.07

Table 4: Economics of wheat

Treatment	Yields (q ha^{-1})		Cost of cultivation	Gross returns	Net returns	B:C ratio
	Grain	Straw	(Rs ha^{-1})			
1. Control	18.73	27.54	15306	36681	21375	2.45
2. GRDF	31.62	43.96	33381	67009	33629	2.00
3. AST	37.44	53.54	33888	79282	45394	2.34
4. 125% of RDF	38.27	52.31	34483	80837	46354	2.42
5. 150% of RDF	40.28	55.50	35584	85213	49629	2.35
SE±	0.94	1.54	-	3540	2967	-
CD at5%	2.91	4.75	-	9487	9150	-

Conclusion

From the results of the above experiment, it is concluded that application of 150 per cent of general recommended dose of fertilizers to wheat crop after grain maize crop produces higher grain and straw yields over absolute control. Also the ancillary characters like thousand grain weight and number of grains per earhead are improved due to application of 150 per cent of general recommended dose of fertilizers for wheat crop.

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