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RESEARCH PAPER

Productivity and quality of maize and wheat under integrated potassium management in maize - wheat cropping system

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Abstract : A field experiment was conducted during 2010-11 and 2011-12 at Indian Agriculture Research Institute, New Delhi to study the productivity and profitability of application of different source of potassium in maize – wheat cropping system. The experiment was laid out in Randomized Block Design consists of ten treatments and replicated thrice. Results revealed that potassium application irrespective of sources was superior over control. Application of 60 kg K through muriate of potash + 30 kg K through farmyard manure in both maize and wheat resulted into higher yield attributes, grain yield and nutrient concentration. This treatment was closely followed by 30 kg K through muriate of potash + 30 kg K through farmyard manure in both maize and wheat which was found significantly superior over 60 kg K through muriate of potash alone and treatment without potassium application.

Key Words : Farmyard manure, Maize, Wheat, Quality, Integrated potassium management

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INTRODUCTION

Potassium is the only essential plant nutrient that is not a constituent of any plant part and plays a key role in adaptation to both abiotic and biotic stresses such as cold/ heat, drought and pest problems. The maize - wheat cropping system is very important cropping system for meeting local food needs and ensuring food security. There is a growing evidence of increasing deficiency of potassium (K) as a result of imbalanced use of nitrogen (N) and phosphorus (P). Even with optimum rates of NPK application in long term experiments, the K balance under most of the soil and cropping systems was negative. Unfortunately, K application did not receive due attention, as most of Indian soils were believed to be 'adequate' in native K supply. The neglect of K application in India is evident from the highly imbalanced fertilizer consumption ratio in respect of K. Keeping in view the above facts the present study was very much needed to see the effect of applied potassium on the yield and quality of the maize and wheat in maize - wheat cropping system.

MATERIALS AND METHODS

A field experiment was carried at Indian Agricultural Research Institute, New Delhi during 2010-2011. The sandy loam soil had pH 8.0, organic carbon 0.4 per cent and available N, P and K 173.2 kg ha^{-1}, 13.8 kg ha^{-1} and 261 kg $ha^{-1,}$ respectively.The experiment was laid out in Randomized Block Design with three replication and ten treatment combination under different sets of treatment for both maize in *Kharif* and wheat in *Rabi* season crops at fixed site. Recommended dose of 150 kg N $ha^{-1}$and 26 kg P ha^{-1}were applied to maize through urea and DAP, respectively. The full dose of P, K and 50 kg N ha^{-1} were given as basal and remaining 100 kg N ha^{-1} was applied in split dose as top dressing at 30 and 50 60 DAS. Muriate of potash (MOP) and farmyard manure (FYM) were used as sources of potassium and applied as per the treatments. The nitrogen and phosphorus content of DAP and FYM were compensated in all the treatments by adjusting amount of urea and DAP. Wheat was given recommended dose of 120 kg N ha^{-1} and 26 kg P ha^{-1} through urea and DAP. Similarly, potassium was applied as

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per treatments; No K to maize and wheat – K_0 (M) – K_0 (W), 60 kg K ha^{-1} through MOP in maize and no K in wheat – 60 kg MOP $_{60}$ (M) – K_0(W), 30 kg K through MOP and 30 kg K through FYM in maize and 60 kg K through MOP in wheat – MOP_{30} + FYM_{30}(M) –MOP_{60} (W), 60 kg K through MOP and 30 kg K through FYM in maize and no K in wheat – MOP_{60} + FYM_{30} (M) – K_0 (W), 30 kg K through MOP and 30 kg K through FYM in maize and no K in wheat – MOP_{30} + FYM_{30} (M)–K_0 (W), no K in maize and 60 kg K through MOP in wheat – K_0 (M) –MOP_{60} (W), no K in maize and 30 kg K through MOP and 30 kg K through MOP in wheat– K_0 (M)– MOP_{30} + FYM_{30} (W), 60 kg K through MOP in maize and 30 kg K though MOP and 30 kg K through FYM in wheat – MOP_{60} (M) – MOP_{30} + FYM_{30} (W), 60 kg K through MOP in maize and 60 kg K through MOP in wheat – MOP_{60} (M)– MOP_{60} (W), no K in maize and 60 kg K through MOP and 30 kg K through FYM in wheat – K_0 (M) –MOP_{60} + FYM_{30} (W). In both the crops all the nutrients were given by broadcast and thoroughly mixed in the soil before sowing. "PEHM -2" variety was sown at spacing of 60 cm x 20 cm at seed rate of 20 kg $ha^{-1}$for maize and "HD 2967" variety was sown at spacing of 22.5 cm row spacing at seed rate of 100 kg ha^{-1}. Grains of maize and wheat were analyzed for N, P and K concentration following standard procedures. The data analyzed and provided as pooled mean by following appropriate statistical analysis.

RESULTS AND DISCUSSION

The experimental findings obtained from the present study have been discussed in following heads:

Yield attributes and yield of maize :

The data in Table 1 showed that application of potassium significantly improved the yield attributes and yield over control in both maize and wheat crop. In maize treatment MOP_{60} + FYM_{30} (M) – K_0 (W) was showed highest grain weight cob^{-1}, cob length, grain rows cob^{-1}, grain yield, straw yield and harvest index. Application of 50% K dose (30 kg K ha^{-1}) through FYM + 50% K (30 kg K ha^{-1}) through MOP was recorded significantly higher yield over 60 kg K ha^{-1} through MOP alone and found at par for grain weight cob^{-1}, cob length grain rows cob^{-1} straw yield and harvest index. In case of wheat highest grain weight $spike^{-1}$, effective tillers m^{-2}, spike length grain yield and straw yield was recorded with treatment K_0 (M) – MOP_{60} + FYM_{30} (W) was found at par with treatments applied with 60 kg K applied with combination of FYM and MOP.

The improvement in yield attributes was due to applied potassium as it is vital to many plant processes including photosynthesis, translocation of photsynthates, protein synthesis, activation of plant enzymes etc. Tabatabaii *et al*. (2011) found that application of 0 to 200 kg K ha^{-1} increased grain number per row, grain weight per row, number of leaves, stem diameter, biomass and 1000 grain weight that increased grain yield of corn. Sharma and Subehia (2003) reported that integrated use of FYM with balanced chemical fertilizers gave higher yield compared to 100% NP and 100% NPK fertilizers. Saifullah *et al.* (2002) observed the response of applied K- fertilizer levels (0, 75, 150, 225 and 300 kg K_2O ha^{-1}) and found that application of 225 kg ha^{-1} K_2O significantly increased number of tillers $plant^{-1}$, number of grain $spike^{-1}$, 1000- grain weight, grain and straw yield. Rehman *et al.* (2008) reported that different levels of NPK and FYM alone or in combination had significant effect on emergence m^{-2}, spikes m^{-2}, grains

Table 1 : Effect of integrated potassium management on yield attributes and yield in maize- wheat cropping system

Treatments	Maize						Wheat					
	Grain weight cob^{-1} (g)	Cob length (cm)	Grain rows cob^{-1}	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)	Grain weight $spike^{-1}$ (g)	Spike length (cm)	Effective $tillers m^{-2}$	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)
K_0 (M) – K_0 (W)	31.8	14.6	12.2	2.5	4.9	33.4	1.5	9.9	267	3.8	7.4	34.1
MOP $_{60}$ (M) – K_0(W)	44.3	17.0	13.6	3.6	5.7	38.4	1.6	11.2	281	4.1	7.9	34.3
MOP_{30}+FYM_{30}(M) –MOP_{60} (W)	50.6	17.9	13.8	4.3	6.3	40.2	2.1	12.0	326	5.0	8.3	37.5
MOP_{60}+ FYM_{30} (M) – K_0(W)	59.0	19.7	14.5	4.9	6.8	42.0	1.7	11.4	292	4.3	7.9	35.0
MOP_{30}+ FYM_{30} (M) – K_0(W)	50.1	17.9	13.6	4.3	6.2	40.9	1.7	11.3	285	4.1	7.9	34.3
K_0(M) –MOP_{60} (W)	34.3	15.0	12.7	2.6	5.1	33.6	2.1	11.7	321	4.8	8.0	37.6
K_0(M) – MOP_{30}+ FYM_{30}(W)	35.3	15.3	12.7	2.6	5.1	34.0	2.3	12.3	353	5.2	8.4	38.2
MOP_{60} (M) – MOP_{30} + FYM_{30} (W)	46.5	17.2	13.7	3.6	5.8	38.0	2.3	12.2	349	5.1	8.5	37.7
MOP_{60} (M) – MOP_{60} (W)	45.3	17.2	13.6	3.6	5.8	37.9	2.1	11.9	319	4.8	8.1	37.5
K_0 (M) –MOP_{60} +FYM_{30} (W)	35.8	15.1	12.7	2.7	5.2	34.3	2.5	12.6	377	5.4	8.6	39.0
S.E.±	2.3	0.6	0.5	0.2	0.2	1.3	0.1	0.4	9	0.2	0.4	1.1
LSD(P=0.05)	6.6	1.8	1.3	0.5	0.6	3.7	0.3	1.2	25	0.5	1.0	3.1

Table 2 : Effect of integrated potassium management on quality of grain in maize - wheat cropping system

Treatments	Maize					Wheat				
	N (%)	P (ppm)	K (ppm)	Zn (ppm)	Fe (ppm)	N (%)	P (ppm)	K (ppm)	Zn (ppm)	Fe (ppm)
K_0 (M) – K_0 (W)	1.55	0.325	0.42	21.3	44.7	1.42	0.267	0.43	25.8	20.6
MOP_{60} (M) – K_0(W)	1.71	0.344	0.51	26.4	48.3	1.48	0.273	0.45	26.6	20.8
MOP_{30}+FYM_{30}(M) –MOP_{60}(W)	1.80	0.357	0.55	28.4	53.2	1.72	0.343	0.55	32.0	23.9
MOP_{60}+FYM_{30}(M) – K_0(W)	1.87	0.374	0.60	31.6	56.4	1.58	0.287	0.46	27.9	21.1
MOP_{30}+FYM_{30}(M) – K_0(W)	1.77	0.356	0.53	29.6	52.2	1.54	0.280	0.45	27.3	20.9
K_0(M) –MOP_{60} (W)	1.56	0.326	0.43	21.5	44.8	1.66	0.323	0.54	31.9	23.5
K_0(M) – MOP_{30}+ FYM_{30}(W)	1.56	0.327	0.42	21.5	44.5	1.76	0.343	0.57	35.8	25.6
MOP_{60} (M) – MOP_{30} + FYM_{30} (W)	1.72	0.343	0.52	25.9	48.8	1.76	0.340	0.57	35.2	25.9
MOP_{60} (M) – MOP_{60} (W)	1.71	0.344	0.52	26.9	48.2	1.72	0.320	0.54	31.6	23.7
K_0 (M) – MOP_{60} +FYM_{30} (W)	1.56	0.327	0.43	21.3	44.1	1.80	0.350	0.58	39.7	29.7
S.E.±	0.03	0.004	0.01	1.3	0.9	0.04	0.006	0.01	0.9	0.3
LSD(P=0.05)	0.08	0.010	0.04	3.7	2.6	0.10	0.018	0.03	2.6	0.8

spike^{-1}, biological yield and thousand grain weight. Farmyard manure at 45 t ha^{-1} produce the maximum spikes m^{-2} (191.2), grains spike^{-1} (54.4), thousand grain weight (34.6 g) and biological yield (10 t ha^{-1}).

Nutrient concentration in maize and wheat grain :

The nutrient concentration of nutrients in maize and wheat was significantly affected by potassium fertilization (Table 2). Application of 90 kg potassium recorded highest concentration of N, P, K, Zn and Fe in grain over remaining treatments in both maize and wheat.

In maize N and P concentration in grain was higher in treatments with FYM compared to MOP applied alone whereas all the treatment applied with potassium were statistically at par. Concentration of N, P, K, Zn and Fe was found significantly increased in treatment applied with potassium over no potassium. The N content was found statistically at par in all the treatments applied with potassium and it was highest under treatment 90 kg potassium through MOP and FYM. Concentration of P and K was found highest in treatment applied with 90 kg potassium and at par with 60 kg potassium supplemented 30 kg through FYM + 30 kg through MOP. The concentration of Zn and Fe was found significantly highest in treatment applied with 90 kg potassium. The treatments applied with 60 kg applied potassium 30 kg through FYM + 30 through MOP was found at par with 60 kg potassium applied through MOP alone.

Potassium plays a vital role in translocation of nutrients in the plants. Increased concentration of nutrients in grain might be due to increased K application. Potassium has synergistic effect on uptake of nitrogen, phosphorus, zinc and iron due to which all the treatments showed superiority over control. Baque *et al*. (2006) reported that uptake of N, P and K was enhanced with increasing levels of K. Eldardiry *et al*.(2010) reported that application of different K levels results in differential nitrogen uptake by wheat grains. Increasing K rates resulted in significantly increase in P-uptake in straw and grains of wheat. Ranade (2011) found a direct synergistic relationship of potassium with Fe, whereas, Gupta (1995) reported a positive interaction between Zn and potassium due to direct role of potassium in nutrient transloction resulting into increased concentration of Fe and Zn in grain. Katyal and Sharma (1979) showed that organic manures are important source of micronutrients which increase their solubility and release them, because of chelation effect. Similarly, Chaudhary and Narwal (2005) reported that application of FYM helps in increasing availability of micronutrients in the soil.

Conclusion :

It is concluded that application of 90 kg potassium significantly increased yield attributes and yield in maize – wheat cropping system. Increased potassium application improves the quality of grain in both the crop compared to treatments without potassium application.

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