

Influence of graded levels of potassium on balance of NPK and potassium use efficiency of maize crop

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ABSTRACT

The experiment was conducted to know the influence of application of graded levels of potassium on balance of major nutrients (NPK) and potassium use efficiency of maize crop at Zonal Agricultural Research Station, VC Farm, Mandya which comes under southern dry zone of Karnataka. The experiment was laid on sandy loam soil of Mandya with medium NPK levels consisting of nine treatments with three replications. Recommended doses of fertilizers (RDF) were applied at basal and top dressing with and without split application of 50, 100 and 125 per cent of RDF. Results revealed that the highest potassium use efficiency was recorded in treatment receiving recommended NP + 125 per cent of recommended K in two splits (basal and at the time of top dressing) and least K use efficiency was recorded at recommended NP + 75 per cent of recommended K as basal. Higher actual balance of nitrogen was recorded in treatment receiving recommended NP + 75 per cent of recommended K in two splits (basal and at the time of top dressing). Even with the same quantity of P application and high level of native P, the available P_2O_5 content after harvest of crops did not show positive balance. Positive balance of potassium was recorded due to higher levels of potassium application and enough amount of potassium in native soil. Significantly higher potassium uptake was recorded with the application of recommended NP + 125 per cent of recommended K in two splits (basal and at the time of top dressing) compared to other treatment combinations.

Key words: Balance; NPK; potassium; efficiency; RDF; maize

INTRODUCTION

Potassium is the major nutrient required for a variety of crops along with nitrogen and phosphorus for their normal growth and development. However imbalanced use of such nutrients without considering soil test values may often result

in poor economic yields. Numerous studies on soil potassium have been carried out in the past. But there is enough scope to study the availability of soil potassium for plant growth. Maize is one of the most important cereal crops of India. The introduction of high yielding varieties with assured irrigation facilities fostered the adoption of maize

cultivation with increased productivity and helped in enhancing farmers' income leading to emergence of multiple nutrient deficiencies.

Response of maize hybrids to various agro-management practices especially fertilizers, sowing methods and plant population is different. This variable response of maize is mainly due to differences in plant morphology, intraspecific competition among plants and difference in growth rate. Soils of India are generally deficient in nitrogen and phosphorus. Now deficiency of potassium is also being reported from various parts. Therefore application of adequate amount of nitrogen, phosphorus and potassium fertilizers is considered imperative under irrigated conditions. Based on the individual crop response to added fertilizers, the fertilizer recommendations are made. The fertilizer use efficiency of maize crop with respect to individual elements is affected by its proportion in soil. With this view the research work was carried out to know the influence of application of graded levels of potassium on balance of major nutrients (NPK) and potassium use efficiency of maize crop.

MATERIAL and METHODS

The experiment was conducted in the maize growing soils of Mandya district of southern dry zone of Karnataka at Zonal Agricultural Research Station, VC

Farm to know the influence of application of graded levels of potassium on balance of NPK and efficiency of applied potassium to maize (var Hema: NAH 1137) test crop. Soil of the experimental area was sandy loam in texture with neutral pH (7.21) and 266.42 kg/ha available nitrogen, 56.17 kg/ha available phosphorus and 211.56 kg/ha available potassium.

The experiment consisted of nine treatments with varying K doses tested in RCBD with 3 replications. The fertilizer doses were 100, 75 and 40 kg/ha of N, P_2O_5 and K_2O respectively. Nitrogen, phosphorus and potassium were applied through urea, single super phosphate and muriate of potash respectively. The treatments used were T_1 (recommended NPK as per University of Agricultural Sciences, Bangalore (UAS (B) package), T_2 (recommended NPK as per UAS (B) package after 15 days of sowing), T_3 (recommended NP + recommended K in two splits, basal and at the time of top-dressing), T_4 (recommended NP + 75% of recommended K as basal), T_5 (recommended NP + 75% of recommended K in two splits, basal and at the time of top-dressing), T_6 (recommended NP + 125 per cent of recommended K as basal), T_7 (recommended NP + 125 per cent of recommended K in two splits basal and at the time of top-dressing), T_8 (recommended NP only) and T_9 (absolute control).

The balance of NPK was worked out by estimation of N, P and K concentrations in the straw and grain samples; the values were multiplied by the corresponding dry matter yield to get uptake of nutrients by the crop. Balance sheet of nitrogen, phosphorus and potassium was worked out by considering the initial soil available N, P_2O_5 and K_2O status, amount of N, P_2O_5 and K_2O added through FYM and fertilizers and uptake of N, P_2O_5 and K_2O . Expected balance of N, P_2O_5 and K_2O was calculated by subtracting N, P_2O_5 and K_2O by the plant uptake from total N, P_2O_5 and K_2O . Net gain or loss of nutrients was worked out by subtracting actual balance from the expected balance of the nutrients.

RESULTS and DISCUSSION

Effect of graded levels of potassium on balance of major nutrients (NPK) in irrigated maize soils

Nitrogen balance: The actual balance of nitrogen was least in treatment without any fertilizer application as compared to the rest of the treatments (Table 1) and higher actual balance was recorded in treatment T_4 (recommended NP + 75% of recommended K as basal) due to less use efficiency and crop uptake. More crop uptake was recorded in treatment T_7 (recommended NP + 125 per cent of recommended K in two splits basal and at

the time of top -dressing) that could be due to the reason that higher potassium application increases the availability and uptake of nitrogen (synergistic effect of K on N) in maize crop and split application of nitrogen along with FYM might have reduced the losses of N by fixation, leaching and volatilization. Highest nitrogen loss was recorded in the treatment receiving recommended NP only. It might be due to absence of potassium that reduced the nitrogen availability and crop uptake and thus less crop production was reported. Highest gain of nitrogen was noticed in control which could be due to least uptake of nitrogen by crop from the soil. These results are supported by the observations made by Husnain et al (2010) and Sukristiyonubow et al (2012).

Phosphorus balance: Available P_2O_5 balance was negative in all the treatments except control (Table 1). The lower P_2O_5 uptake during the crop growth was noticed in treatment without any fertilizer application (control). Even with the same quantity of P application and high level of native P, the available P_2O_5 content after harvest of crops did not show positive balance due to high P fixation capacity on the clay complexes. Similar results were obtained by Husnain et al (2010) and Steiner et al (2012).

Potassium balance: Higher potassium uptake was recorded in T_7 (recommended NP + 125 per cent of recommended K in

Table1. Balance of nitrogen, phosphorus and potassium (kg/ha) in soil after harvest of maize as influenced by application of graded levels of potassium

Treatment	IA (1)	Through FYM & F (2)	Total (3: 1 + 2)	CU (4)	EB (5: 3 - 4)	AB (6)	G/L (7: 6 - 5)
Balance of nitrogen (kg/ha)							
T ₁	266.42	199.99	466.41	171.20	295.21	299.84	4.63
T ₂	266.42	199.99	466.41	170.59	295.82	292.49	-3.33
T ₃	266.42	199.99	466.41	173.03	293.38	288.04	-5.34
T ₄	266.42	199.99	466.41	133.29	333.12	300.28	-32.84
T ₅	266.42	199.99	466.41	135.84	330.57	300.86	-29.71
T ₆	266.42	199.99	466.41	210.71	255.70	282.54	26.84
T ₇	266.42	199.99	466.41	211.75	254.96	276.86	21.90
T ₈	266.42	199.99	466.41	107.52	358.89	271.30	-87.59
T ₉	266.42	0	266.42	81.57	184.85	256.53	71.68
Balance of phosphorus (kg/ha)							
T ₁	56.17	100	156.17	43.78	112.39	84.19	-28.20
T ₂	56.17	100	156.17	41.01	115.16	81.21	-33.94
T ₃	56.17	100	156.17	44.26	111.91	76.20	-35.71
T ₄	56.17	100	156.17	29.78	126.39	68.18	-58.21
T ₅	56.17	100	156.17	30.46	125.71	67.94	-57.77
T ₆	56.17	100	156.17	32.53	123.64	59.60	-64.04
T ₇	56.17	100	156.17	31.97	124.20	58.03	-66.17
T ₈	56.17	100	156.17	23.56	132.61	55.54	-77.07
T ₉	56.17	000	56.17	16.03	40.14	47.61	7.47
Balance of potassium (kg/ha)							
T ₁	221.56	89.6	311.16	183.21	127.95	228.71	100.76
T ₂	221.56	89.6	311.16	178.34	132.82	225.65	92.84
T ₃	221.56	89.6	311.16	183.44	127.72	229.32	101.60
T ₄	221.56	80.0	301.56	128.22	173.34	218.94	45.59
T ₅	221.56	80.0	301.56	136.51	165.05	218.16	53.11
T ₆	221.56	99.9	321.55	232.82	88.73	208.47	119.74
T ₇	221.56	99.9	321.55	234.91	86.64	207.26	120.62
T ₈	221.56	00.0	221.56	92.30	129.26	194.93	65.66
T ₉	221.56	00.0	221.56	63.60	157.96	186.01	28.06

T₁ (recommended NPK as per University of Agricultural Sciences, Bangalore (UAS (B) package), T₂ (recommended NPK as per UAS (B) package after 15 days of sowing), T₃ (recommended NP + recommended K in two splits, basal and at the time of topdressing), T₄ (recommended NP + 75% of recommended K as basal), T₅ (recommended NP + 75% of recommended K in two splits, basal and at the time of topdressing), T₆ (recommended NP + 125 per cent of recommended K as basal), T₇ (recommended NP + 125 per cent of recommended K in two splits basal and at the time of topdressing), T₈ (recommended NP only) and T₉ (absolute control), IA: Initial available, FYM & F: FYM and fertilizer, CU: Crop uptake, EB: Estimated balance, AB: Actual balance, G/L: Gain or loss

two splits basal and at the time of top-dressing) compared to other treatments (Table 1) that could be due to high potassium use efficiency of maize crop and availability of K by application of higher levels of potassium. High actual balance was recorded by the application of recommended NP + recommended K in two splits (basal and at the time of top-dressing) which could be due to high potassium availability and potassium use efficiency but it was less than the application of recommended dose of NP and recommended K in two splits. Least actual balance was recorded in the absolute control. Positive balance was recorded in all the treatments due to application of high potassium levels and enough amount of potassium in native soil. Similar results were obtained by Zeng et al (1999), Skowrońska and Filipek (2010), Husnain et al (2010), Steiner et al (2012) and Sukristiyonubow et al (2012).

Effect of graded levels of potassium on potassium use efficiency

Data pertaining to the effect of graded levels of potassium on potassium use efficiency of potassium in irrigated maize are presented in Table 2.

Highest potassium use efficiency (49.34%) was recorded with T₇ (recommended NP + 125 per cent of recommended K in two splits basal and at the time of top-dressing) and it was on par with T₆ (recommended NP + 125

per cent of recommended K as basal). The least K use efficiency was recorded at T₄ (recommended NP + 75% of recommended K as basal) with a value of 28.31 per cent which might be due to the higher requirement of potassium by maize crop and presence of low to medium potassium availability in soil. Application of graded doses of potassium in splits reduces the fixation and losses of potassium in soil by increasing the crop availability and uptake by crop and it increases the use efficiency of potassium. These results are supported by the findings of Arif et al (2010), Brar et al (2011), Ahmad et al (2012) and Bello et al (2012).

CONCLUSION

Split application of potassium increased the efficiency and availability of nutrients. However the higher potassium use efficiency (49.34%) was recorded with the application of T₇ (recommended NP + 125 per cent of recommended K in two splits basal and at the time of top-dressing), which was on par with the recommended NP + 125 per cent recommended K application (basal). Balance of soil NPK after harvest of maize crop varied significantly due to imposition of graded levels of potassium with recommended NP. There was negative balance of NP among the treatments whereas uptake was more and balance of K was more in control with least uptake.

Table 2. Potassium use efficiency of maize crop as influenced by application of graded levels of potassium

Treatment	YKFAP (1)	YCP (2)	YKFAP - YCP (3: 1 - 2)	(YKFAP - YCP)/YKFAP (4: 3/1)	PUE (%) 4/100
T ₁	7388	4205	3183	0.43	43.08
T ₂	6697	4205	2492	0.37	37.21
T ₃	6703	4205	2498	0.37	37.26
T ₄	5866	4205	1661	0.28	28.31
T ₅	5909	4205	1704	0.28	28.83
T ₆	7945	4205	3740	0.47	47.07
T ₇	8302	4205	4097	0.49	49.35
T ₈	-	-	-	-	-
T ₉	-	-	-	-	-

T₁ (recommended NPK as per University of Agricultural Sciences, Bangalore (UAS (B) package), T₂ (recommended NPK as per UAS (B) package after 15 days of sowing), T₃ (recommended NP + recommended K in two splits, basal and at the time of topdressing), T₄ (recommended NP + 75% of recommended K as basal), T₅ (recommended NP + 75% of recommended K in two splits, basal and at the time of topdressing), T₆ (recommended NP + 125 per cent of recommended K as basal), T₇ (recommended NP + 125 per cent of recommended K in two splits basal and at the time of topdressing), T₈ (recommended NP only) and T₉ (absolute control), YKFAP= Yield of K fertilizer added plot, YCP= Yield of control plot, PUE (%)= Potassium use efficiency

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