Available online at www.ijpab.com

DOI: http://dx.doi.org/10.18782/2320-7051.6007

ISSN: 2320 – 7051

Int. J. Pure App. Biosci. **6 (1):** 1028-1032 (2018)

Research Article

International Journal of Pure & Applied Bioscience

OPEN ACCESS

Effect of Phosphorous Nutrition through Foliar and Irrigation on Budgeting of Primary Macro Nutrients in Drip Fertigated Maize

Harshitha B. V., Denesh G. R.* and Fathima P. S.

College of Agriculture, GKVK, University of Agricultural Sciences, Bangalore, Karnataka

*Corresponding Author E-mail: harshi.bv@gmail.com

Received: 18.11.2017 | Revised: 23.12.2017 | Accepted: 29.12.2017

ABSTRACT

The field experiment was conducted in maize under paired row drip irrigation and fertigation (Nitrogen and potash) during kharif 2016 at Agronomy field unit, College of Agriculture, V.C. Farm, Mandya, University of Agricultural Sciences, Bangalore, Southern dry zone of Karnataka to determine the effect of foliar nutrition of water soluble phosphorus fertilizer application and irrigation levels on budgeting of primary macro nutrients (Viz., nitrogen, phosphorous and potassium). The results revealed that FA of WSPF at 15 or 20 kg ha^{-1} along with irrigation at 80% CPE recorded higher crop uptake of nitrogen (246.2 to 254.9 kg ha^{-1}), phosphorus (45.7 to 48.1 kg ha^{-1}) and potassium (207.7 to 229.2 kg ha^{-1}) and were comparable with soil application of SSP along with irrigation at 80% CPE. Added this, higher net gain of nitrogen (+ 47.7 kg ha^{-1}) with FA of WSPF at 15 kg ha^{-1} and lower net loss of phosphorus (-36.53 kg ha^{-1}) with FA of WSPF at 10 kg ha^{-1} along with irrigation at 80% CPE. While, higher net gain of potassium (+ 99.94 kg ha^{-1}) was with FA of WSPF at 20 kg ha^{-1} along with irrigation at 100% CPE

Key words: *Maize, Drip irrigation, Primary macro nutrients, Nutrient budgeting.*

INTRODUCTION

Maize (*Zea mays* L.) is one of the most versatile emerging cash crop having wider adaptability under varied climatic and management conditions. The crop is called queen of cereals due to its higher genetic yield potential, diverse use, adaptation to varied climatic conditions and for being staple food. The maize is highly responsive to applied fertilizers and irrigation for desired productivity. The foliar nutrition is one of the emerging field in nutrient management and in specific, application of phosphorus (P) through foliar can increase the P content in plants as compared to soil application and uptake due to higher fixation of P in soil[6]. Further, optimum moisture in root zone of crop could favour adequate availability and uptake of other nutrients apart from supplying required moisture. Thus an attempt has been made to budget the nutrients in drip fertigated maize with foliar nutrition of P, the new method of fertilizer management in comparison with the fertigation and soil application.

Cite this article: Harshitha, B.V., Denesh, G. R. and Fathima, P.S., Effect of Phosphorous Nutrition through Foliar and Irrigation on Budgeting of Primary Macro Nutrients in Drip Fertigated Maize, *Int. J. Pure App. Biosci.* **6(1):** 1028-1032 (2018). doi: http://dx.doi.org/10.18782/2320-7051.6007

MATERIAL AND METHODS

The field experiment was conducted at Agronomy field unit, College of Agriculture, V. C. Farm, Mandya during 2016-17. The soil of the experimental site was sandy loam with medium OC (0.65 %), EC (0.23 dS m^{-1}), low in available nitrogen (179.80 kg ha^{-1}), high in phosphorus (48.33 kg ha^{-1}) and medium in potassium (329.76 kg ha^{-1}) content. The experiment was laid out in Factorial-RCBD comprising of two factors *viz*., irrigation at two levels (100 and 80 % CPE) and phosphorus application methods at five levels [10, 15 and 20 kg ha^{-1} foliar application (FA) of water soluble phosphorus fertilizer (WSPF) and were compared with recommended dose of P (75 kg ha^{-1}) through fertigation of WSPF and soil application of SSP (Single super phosphate)]. The combination of 10 treatments were replicated thrice and N and K given under drip fertigation. The planting geometry adopted was paired row spacing of 30/90cm X 30 cm under drip irrigation. The irrigation was given at 2 days interval based on evaporation data of USWB open pan evaporimeter. Foliar application of phosphorus was given as per the treatment in two equal splits at 20 and 45 DAS by using water soluble Mono ammonium phosphate (MAP) which contains 61% P_2O_5 and 12% N. The phosphorus fertilizers used for fertigation and soil application of phosphorous were MAP and SSP, respectively in the P_4 and P_5 treatments. The recommended dose of nitrogen and potassium were applied by using urea and MOP fertilizer through fertigation stating from 10 DAS up to 58 DAS at an interval of 4 days. The grain and stover samples collected at harvest were digested in tri-acid mixture. The nitrogen, phosphorus and potassium contents in the extract were determined by K. Jeldhal, Venadomolybdate and flame photometer method, respectively then the NPK uptake in kg per hectare by grain and straw was worked out. Soil samples before the land preparation and after harvest of the crop were collected and chemical analysis was carried out to know the nutrient status of soil. The available nitrogen, phosphorus and potassium in soil were estimated by alkaline pre-germinate, Brays and Neutral in NH_4 OAC methods, respectively. Balance sheet of the available nutrients was computed using initial nutrient status, amount of nutrient added through fertilizer and nutrient uptake by crop. Expected balance was estimated by subtracting plant uptake from total nutrient status. Net gain or loss of nutrients was computed by subtracting actual balance from the expected balance of nutrients and the actual balance was known by analyzing the soil after the harvest of the crop.

RESULTS AND DISCUSSION

The balance sheet of available primary macronutrients (N, P_2O_5 and K_2O) was presented in Table 1, 2 and 3. Foliar application (FA) of WSPF at 15 kg ha^{-1} along with irrigation at 80% CPE recorded higher removal and net gain of nitrogen (254.9 and 47.7 kg ha^{-1}, respectively) and was comparable with soil application of SSP along with irrigation at 80% CPE (258.1 and 64.3 kg ha^{-1}, respectively) and lower crop uptake and net loss of nitrogen was in FA of WSPF at 10 kg ha^{-1} along with irrigation at 80% CPE (194.3 and -107.1 kg ha^{-1}, respectively) (Table 1). The net gain of nitrogen may be due to higher removal of nitrogen by maize crop in the former treatment and thus minimized losses of leaching, ammonia fixation, volatilization and denitrification. The results are in line with Mathukia *et al.*[4] and Honnappa[3] in drip fertigated maize. The available phosphorus removal by maize crop and net losses from soil varied with interaction of irrigation levels and phosphorus application methods. Crop removal of P was higher in FA of WSPF at 15 kg ha^{-1} along with irrigation at 80% CPE (48.1 kg ha^{-1}) followed by soil application of SSP along with irrigation at 100% CPE (46.9 kg ha^{-1}) and lower was in FA of WSPF at 10 kg ha^{-1} along with irrigation at 80% CPE (38.0 kg ha^{-1}). Further, net loss of total P from the soil was lower under foliar application of WSPF at 10 to 20 kg /ha (-36.53 to -52.13 kg/ha) as compared to fertigation of WSPF or soil application of recommended SSP (-96.33 to -109.03 kg/ha) either under irrigation at 80 or 100 % CPE (Table 2). Regardless of irrigation levels, the loss of phosphorus may be attributed to the greater fixation of available phosphorous either in fertigation or soil application as compared to foliar application. The results are in conformity with Eghball and Sander[2] and Ali *et al*[1].The higher available potassium removal by maize crop was in

fertigation of WSPF along with Irrigation at 100% CPE (232 kg ha^{-1}) and was closely followed by FA of WSPF at 20 kg ha^{-1} along with irrigation at 80 or 100% CPE (225 to 229.2 kg ha^{-1}). Added to this, higher net gain of soil potassium was higher in FA of WSPF at 20 kg ha^{-1} along with irrigation at 100% CPE (99.94 kg ha^{-1}) followed by soil application of SSP along with irrigation at 80% CPE (78.94 kg ha^{-1}) as compared to rest of the treatments (14.34 to 68.44 kg ha^{-1}) (Table 3). It appearances that crop was not completely utilized the available potassium. The results are in line with Honnappa[3] in drip fertigated maize and Torres[7] under wheat at 10 kg ha^{-1} FA of fertilizer.

Yield and phosphorus use efficiency:

Among irrigation level, irrigation at 80 % CPE recorded higher kernel (5753 kg ha^{-1}) and stover yield of maize (9642 kg ha^{-1}) and was statistically on par with irrigation at 100% CPE (5519 and 9477 kg ha^{-1}) (Table 1). This could be due to irrigation supplied at 80 % CPE was sufficient to meet the consumptive water use of plant. Among P application methods, foliar application (FA) of water soluble phosphorus fertilizer (WSPF) at 15 or 20 kg ha^{-1}recorded higher kernel (5469 to 5787 kg ha^{-1}) and stover yield (9715 to 9722 kg ha^{-1}) of maize and was statistically similar with application of recommended dose of P (75 kg P_2O_5 ha^{-1}) through fertigation of WSPF (5967 and 9520 kg ha^{-1}, respectively) or soil application of SSP (5737 and 9972 kg ha^{-1}, respectively). The higher kernel yield with FA of WSPF could be due higher phosphorus use efficiency (50 %) with foliar application of P as against 10 to 15 per cent in soil applied treatment[6]. Supplementing to this, Phosphorus use efficiency was higher with FA of WSPF at 10 kg ha^{-1} (519.3 kg ha^{-1}) followed by FA of WSPF at 15 or 20 kg ha^{-1}(289.4 to 369.4 kg kg^{-1}), fertigation of WSPF (79.6 kg kg^{-1}) and soil application of SSP (76.5 kg kg^{-1}). Similar results are obtained with Mosali *et al.*[5] for FA of P at 2 kg ha^{-1} (Table 4).From this study it can be inferred that, foliar application of water soluble phosphorus fertilizer at 15 to 20 kg ha^{-1} along with irrigation at 80% CPE resulted in similar uptake of primary macronutrients (246.2 to 254.9, 45.7 to 48.1 and 207.7 to 229.2 kg ha^{-1} N, P_2O_5 and K_2O, respectively) and net gain or loss of soil nutrient balance as compared to fertigation of WSPF or soil application of SSP. Added to this, foliar application of WSPF at 15 to 20 kg/ha can save73 to 80 per cent recommended phosphorus fertilizer and adoption of irrigation at 80% CPE can save 11.17 per cent irrigation water to maize crop in drip irrigation.

Table 1: Balance sheet of available Nitrogen (kg/ha) as influenced by phosphorus foliar nutrition and irrigation levels in maize under drip fertigation

Treatment	Initial status	Addition of N through fertilizer+ VC	Total	Removal of N by Crop	Expected balance	Actual balance	Net gain (+) or loss (-)
1	2	3	4 = (2+3)	5	6 = (4-5)	7	8 = (7-6)
T_1: Irrigation at 100% CPE with foliar application (FA) of WSPF @ 10 kg ha^{-1}	179.8	350	529.8	195.3	334.5	279.2	-55.3
T_2: Irrigation at 100% CPE with FA of WSPF @ 15 kg ha^{-1}	179.8	350	529.8	221.3	308.5	327.1	18.6
T_3: Irrigation at 100% CPE with FA of WSPF @ 20 kg ha^{-1}	179.8	350	529.8	232.8	297	229.9	-67.1
T_4: Irrigation at 100% CPE with fertigation of WSPF	179.8	350	529.8	248.9	280.9	233.9	-47
T_5: Irrigation at 100% CPE with soil application of SSP	179.8	350	529.8	240.5	289.3	322.5	33.2
T_6: Irrigation at 80% CPE with foliar application (FA) of WSPF @ 10 kg ha^{-1}	179.8	350	529.8	194.3	335.5	228.4	-107.1
T_7: Irrigation at 80% CPE with FA of WSPF @ 15 kg ha^{-1}	179.8	350	529.8	254.9	274.9	322.6	47.7
T_8: Irrigation at 80% CPE with FA of WSPF @ 20 kg ha^{-1}	179.8	350	529.8	246.2	283.6	243.4	-40.2
T_9: Irrigation at 80% CPE with fertigation of WSPF	179.8	350	529.8	238.3	291.5	279.3	-12.2
T_{10}: Irrigation at 80% CPE with soil application of SSP	179.8	350	529.8	258.1	271.7	336	64.3

Note: WSPF= Water soluble phosphorus fertilizer; SSP= Single super phosphate; for treatments T_4, T_5, T_9 and T_{10}= 75 kg ha^{-1} recommended dose of P fertilizer applied, VC = Vermicompost @ 5t/ha.

Table 2: Balance sheet of available phosphorous (kg/ha) as influenced by irrigation levels and phosphorous foliar nutrition in maize under drip fertigation

Treatment	Initial status	Addition of P_2O_5 through fertilizer+ VC	Total	Removal of P_2O_5 by Crop	Expected balance	Actual balance	Net gain (+) or loss (-)
1	2	3	4 = (2+3)	5	6 = (4-5)	7	8 = (7-6)
T_1: Irrigation at 100% CPE with foliar application (FA) of WSPF @ 10 kg ha^{-1}	48.33	110	158.33	38	120.33	69.7	-50.63
T_2: Irrigation at 100% CPE with FA of WSPF @ 15 kg ha^{-1}	48.33	115	163.33	39.5	123.83	76.3	-47.53
T_3: Irrigation at 100% CPE with FA of WSPF @ 20 kg ha^{-1}	48.33	120	168.33	43.9	124.43	72.3	-52.13
T_4: Irrigation at 100% CPE with fertigation of WSPF	48.33	175	223.33	43.3	180.03	71	-109.03
T_5: Irrigation at 100% CPE with soil application of SSP	48.33	175	223.33	46.9	176.43	80	-96.43
T_6: Irrigation at 80% CPE with foliar application (FA) of WSPF @ 10 kg ha^{-1}	48.33	110	158.33	40.8	117.53	81	-36.53
T_7: Irrigation at 80% CPE with FA of WSPF @ 15 kg ha^{-1}	48.33	115	163.33	48.1	115.23	69.3	-45.93
T_8: Irrigation at 80% CPE with FA of WSPF @ 20 kg ha^{-1}	48.33	120	168.33	45.7	122.63	74.7	-47.93
T_9: Irrigation at 80% CPE with fertigation of WSPF	48.33	175	223.33	44.3	179.03	70.7	-108.33
T_{10}: Irrigation at 80% CPE with soil application of SSP	48.33	175	223.33	45.3	178.03	81.7	-96.33

Note: WSPF= Water soluble phosphorus fertilizer; SSP= Single super phosphate; for treatments T_4, T_5, T_9 and T_{10}= 75 kg ha^{-1} recommended dose of P fertilizer applied, VC = Vermicompost @ 5t/ha.

Table 3: Balance sheet of available Potassium (kg/ha) as influenced by irrigation levels and phosphorous foliar nutrition in maize under drip fertigation

Treatment	Initial status	Addition of K_2O through fertilizer+ VC	Total	Removal of K_2O by Crop	Expected balance	Actual balance	Net gain (+) or loss (-)
1	2	3	4 = (2+3)	5	6 = (4-5)	7	8 = (7-6)
T_1: Irrigation at 100% CPE with foliar application (FA) of WSPF @ 10 kg ha^{-1}	329.76	165	494.76	205.5	289.26	357.7	68.44
T_2: Irrigation at 100% CPE with FA of WSPF @ 15 kg ha^{-1}	329.76	165	494.76	213.9	280.86	302.3	21.44
T_3: Irrigation at 100% CPE with FA of WSPF @ 20 kg ha^{-1}	329.76	165	494.76	225	269.76	369.7	99.94
T_4: Irrigation at 100% CPE with fertigation of WSPF	329.76	165	494.76	232	262.76	328.7	65.94
T_5: Irrigation at 100% CPE with soil application of SSP	329.76	165	494.76	202.4	292.36	306.7	14.34
T_6: Irrigation at 80% CPE with foliar application (FA) of WSPF @ 10 kg ha^{-1}	329.76	165	494.76	186.3	308.46	370	61.54
T_7: Irrigation at 80% CPE with FA of WSPF @ 15 kg ha^{-1}	329.76	165	494.76	207.7	287.06	349	61.94
T_8: Irrigation at 80% CPE with FA of WSPF @ 20 kg ha^{-1}	329.76	165	494.76	229.2	265.56	314	48.44
T_9: Irrigation at 80% CPE with fertigation of WSPF	329.76	165	494.76	213.3	281.46	322.7	41.24
T_{10}: Irrigation at 80% CPE with soil application of SSP	329.76	165	494.76	224.7	270.06	349	78.94

Note: WSPF= Water soluble phosphorus fertilizer; SSP= Single super phosphate; for treatments T_4, T_5, T_9 and T_{10}= 75 kg ha^{-1} recommended dose of P fertilizer applied, VC = Vermicompost @ 5t/ha.

Table 4: Kernel yield, Stover yield and phosphorus use efficiency (PUE) as influenced by irrigation levels and foliar nutrition of phosphorus in maize under drip fertigation

Treatments	Kernel yield (kg ha^{-1})	Stover yield (kg ha^{-1})	P applied (kg ha^{-1})	PUE (kg kg^{-1})
Factor- A: Irrigation levels				
I_1: 100 % CPE	5519	9477	-	-
I_2: 80 % CPE	5753	9642	-	-
S.Em±	159.53	362	-	-
CD (p= 0.05)	NS	NS		
Factor- B: Phosphorus application methods				
P_1: Foliar application (FA) of WSPF @ 10 kg ha^{-1}	5193	8867	10	519.30
P_2: FA of WSPF @ 15 kg ha^{-1}	5496	9715	15	366.40
P_3: FA of WSPF @ 20 kg ha^{-1}	5787	9722	20	289.40
P_4: Fertigation of WSPF.	5967	9520	75	79.60
P_5: Soil application of SSP	5737	9972	75	76.50
S.Em±	252.24	572	NA	NA
CD (p= 0.05)	749	NS		
Interaction				
T_1: I_1P_1	5014	8678	10	501.40
T_2: I_1P_2	5203	9444	15	346.90
T_3: I_1P_3	5832	11873	20	291.60
T_4: I_1P_4	5982	10263	75	79.80
T_5: I_1P_5	5567	9778	75	74.20
T_6: I_2P_1	5372	9056	10	537.20
T_7: I_2P_2	5790	9985	15	386.00
T_8: I_2P_3	5741	10222	20	287.10
T_9: I_2P_4	5952	8778	75	79.36
T_{10}: I_2P_5	5907	10167	75	78.76
S.Em±	356.73	809	NA	NA
CD (p= 0.05)	NS	NS		
CV %	10.96	14.65		

Note: WSPF= Water soluble phosphorus fertilizer, P= Phosphorus, SSP= Single super phosphate, for treatments P_4 and P_5= 75 kg ha^{-1} recommended dose of P fertilizer applied.

REFERENCES

1. Ali, M.S., Sutradhar, A., Edano, M.L., Edwards, J.T. and Girma, K., Response of winter wheat grain yield and phosphorus to foliar phosphate fertilization. *Intl. J. Agron.,* 1-8 (2011).
2. Eghball, B. and Sander, D.H., Band spacing effects of dual-placed nitrogen and phosphorus fertilizers on corn. *Agron. J.*, **81:** 178-184 (1989).
3. Honnappa, Studies on drip fertigation under different planting geometry in maize (*Zea mays* L.). *M. Sc. (Agri.) Thesis*, University of Agricultural Sciences, Bangalore (2014).
4. Mathukia, R.K., Gohil, B.S., Mathukia, P.R. and Chhodavadia, S.K., Optimization of irrigation and fertilizer for sweet corn (*Zea mays* L. Var. *Saccharata* sturt) under climate change conditions. *Innovare J. Agric. Sci.,* **3(1):** 1-3 (2011).
5. Mosali, J., Desta, K., Teal, R.K., Freeman, K., Martin, K.L. and Lawles, J.W., Effect of foliar application of phosphorus on winter wheat grain yield, phosphorus uptake, and use Efficiency. *J. Plant Nutrition*, **29:** 2147-2163 (2001).
6. Syers, J.K., Johnsandn, A.E. and Curtis D., Efficiency of soil and fertilizer phosphorus use: Reconciling concepts of soil phosphorus behavior with agronomic information. *Fertilizer and Plant Nutrition Bulletin, FAO, Vienna* (2007).
7. Torres, G.M., Foliar phosphorus fertilization and effect of surfactants on winter wheat (*Triticum aestium* L.). *M. Sc. Thesis*, Oklahoma State University, Brazil (2011).