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Effect of Nano-Potassium Fertilizer on Yield and Economics of Maize (*Zea mays* L.)

K. J. Beeresha and H. M. Jayadeva
Department of Agronomy, College of Agriculture, UAS, GKVK, Bengaluru-560 065
e-mail : jayadev98@rediffmail.com

Abstract

A field experiment was conducted to study the effect of Nano-potassium fertilizer on performance of maize crop during *kharif* 2017 at Zonal Agricultural Research Station (ZARS), UAS, GKVK, Bengaluru in red sandy loam soil (pH 6.56; OC 0.43 %) with medium available nitrogen (428 kg ha^{-1}), phosphorus (46 kg ha^{-1}), potassium (244 kg ha^{-1}) and zinc (0.48 mg kg^{-1}). Experiment was laid out in RCBD with 10 treatments replicated thrice and the maize cultivar was BRMH-1. The soil application of K_2O at 15 kg ha^{-1} + foliar application of nano potassium (Nano - K) at 2500 ppm resulted significantly higher cob length (17.9 cm), cob girth (17.2 cm), number of rows cob^{-1} (16.8), number of kernels row^{-1} (41.3), number kernels cob^{-1} (694.8), weight of kernels cob^{-1} (188.4 g), test (34.80 g), kernel yield (9051 kg ha^{-1}), straw yield (11667 kg ha^{-1}), gross returns (Rs.138330 ha^{-1}) and net returns (Rs.88240 ha^{-1}). Whereas, higher B:C (4.02) was noted with RDF as per package of practices.

Keywords : Mano potassium, Maize, K_2O

Maize (*Zea mays* L.) is the third most important cereal crop in the world after wheat and rice cultivated in an area of 186 m ha and production of 1075 mt with productivity of 5490 kg ha^{-1} (Anon., 2017). Maize is considered as 'Queen of Cereals' because of its high production potential and wider adaptability. In India, it is grown in an area of 9.89 m ha with a production of 25.90 mt and the productivity of 2620 kg ha^{-1} (Anon., 2017). In addition to staple crop for human being and quality feed for animals, maize serves as a basic raw material for production of starch, oil, protein, alcohol beverages, food sweeteners and more recently as a potential bio-fuel crop. In India, maize occupies important place as food (25%), animal feed (12%), poultry feed (49%), industrial products like starch (12%), brewery (1%) and seed (1%).

The nutrient use efficiencies of conventional fertilizers hardly exceed 30-35 per cent, 18-20 per cent and 35-40 per cent for N, P and K, respectively and has reached pleatau stage. Hence, there is a need for increasing nutrient efficiency through nano fertilizer technology. Nano fertilizer technology is very innovative and little literature is available in the scientific journals. According to Royal Society, 'Nano technologies are the design, characterization, production and application of structures, devices and systems by controlling shape and size at nanometer scale' (Chinnamuthu and Boopathi, 2009). Nano - fertilizers are the nutrient carriers that are being developed using substrates with nano dimensions of 1-100 nm. Nano particles have extensive surface area and capable of holding abundance of nutrients and release them slowly and steadily. So that there is a synchrony between soil nutrient availability and crop nutrient requirement and avoids the ill-effects associated with customized fertilizer inputs. In addition, nano fertilizers will combine nano devices in order to synchronize the release of fertilizer -N and -P with their uptake by crops, so preventing undesirable nutrient losses to soil, water and air-via-direct internalization by crops, and avoiding the interaction of nutrients with soil, microorganisms, water, and air (Derosa *et al.,* 2010).

Among the major nutrients, potassium plays a vital role in plant processes *viz.,* photosynthesis, translocation of photosynthates, protein synthesis, control of ionic balance, regulation of plant stomata and water use, activation of plant enzymes and many other processes. It also activate sixty enzymes that are involved in plant growth. Plants deficient in potassium are less resistant to drought, excess water, high and low temperatures. They are also less resistant to incidence pests, diseases and nematode. Potassium is also known as the quality nutrient as improves the quality of agricultural produce in terms of size, shape, color, taste, shelf life, fiber quality and other quality parameters. Keeping these points in view, the present investigation was undertaken to study the effect of nano-potassium on yield and economics of maize.

Material and Methods

A field experiment was conducted during *kharif* 2017 at ZARS, GKVK, Bengaluru in red sandy loam soil (pH 6.56; OC 0.43 %), with medium available nitrogen (428 kg ha^{-1}), phosphorus (46 kg ha^{-1}), potassium (244 kg ha^{-1}) and zinc (0.48 mg kg^{-1}). The experiment comprised of 10 treatments *viz*., T_1: Soil application of Nano K at 25 kg ha^{-1}, T_2 : Soil application of Nano-K at 20 kg ha^{-1}, $T_{3:}$ Soil application of Nano-K at 15 kg ha^{-1}, T_4: Soil application of Nano- at 10 kg ha^{-1}, T_5: Soil application of Nano-K at 05 kg ha^{-1}, T_6: Soil application of K_2O at 15 kg ha^{-1} + foliar application of 2500 ppm Nano-K, T_7: Soil application of K_2O at 15 kg ha^{-1} + foliar application of 2000 ppm Nano-K, T_8: Soil application of K_2O at 15 kg ha^{-1} + foliar application of 1500 ppm Nano - K, T_9: Soil application of K_2O at 15 kg ha^{-1} + foliar application of 1000 ppm Nano-K and T_{10}: Recommended dose of fertilizers (150 kg N -75 kg P_2O_5 ha^{-1} - 40 kg K_2O ha^{-1}). The treatments were laid out in randomised complete block design (RCBD) and were replicated thrice. The gross plot size was 5.6 m x 3.6 m = 19.44 m^2.

The Nano potassium formulation has gluconates as carrier for bio potassium, which facilitates fast absorption and complete utilization. Nano potassium contain 7 per cent K_2O and other micronutrients like zinc, iron, copper and manganese with a concentration of 5-10 ppm. The recommended package of practices (RPP) include application of FYM @ 10 t + 150 kg N +75 kg P_2O_5 and 10 kg $ZnSO_4$ ha^{-1} to the all the treatments. The foliar application of nano K was taken up at 30 and 60 days after sowing. The test cultivar of maize BRMH-1 was sown at a spacing of 60 cm × 30 cm. All other agronomic practices were followed as per the UAS, Bangalore recommended package of practices. Observations were made at harvest for yield and yield parameters of maize. The cost of Nano potassium was Rs.96 kg^{-1}. The dosage for foliar application were 2500 ppm, 2000 ppm, 1500 ppm and 1000 ppm as per treatments. The harvest index can be calculated by (HI)=Economic yield / Biological yield and B:C ratio=Gross returns (Rs.ha^{-1}) / Cost of cultivation (Rs.ha^{-1}). The experimental data was analyzed by using ANOVA technique. The significance of the treatment effect was judged with the help of 'F' table and tested at 5 per cent probability level.

Results and Discussion

The results from the study revealed that higher cob length (17.9 cm), cob girth (17.2 cm), number of rows per cob (16.8), number of kernels per row (41), number of kernel per cob (695), kernel weight per cob (188 g) and hundred kernel weight (34.80 g) were recorded with soil application of K_2O at 15 kg ha^{-1} + foliar application of 2500 ppm Nano-K followed by soil application of K_2O at 15 kg ha^{-1} + foliar application of 2000 ppm Nano-K and soil application of K_2O at 15 kg ha^{-1} + foliar application of 1500 ppm Nano-K (Table 1). However, among the treatments evaluated, soil application of Nano-K at 05 kg ha^{-1} K resulted in lower cob length, cob girth, number of rows per cob, number of kernels per row, number of kernel per cob, kernel weight per cob and hundred kernel weight were recorded with soil application of Nano-K at 5 kg ha^{-1}. The increase in yield parameters in soil application of K_2O at 15 kg ha^{-1} + foliar application of 2500 ppm Nano K might be due to increased translocation of assimilates from source to sink, as potassium was directly involved in biosynthesis and translocation of sugars (Sirisena *et al*., 2013).

Significantly higher kernel and stover yield (9051 and 11667 kg ha^{-1}, respectively) was noted with in soil application of K_2O at 15 kg ha^{-1} + foliar application of 2000 ppm Nano-K as compared to rest treatments. The increase in kernel yield was due to increased yield parameters like cob length, girth of the cob, number

TABLE 1

Effect of Nano Potassium fertilizer on yield attributes of maize during *kharif* 2017

Treatments	Cob length (cm)	Cob girth (cm)	No. of rows cob^{-1}	No. of kernels row^{-1}	No. of kernels cob^{-1}	Kernel weight cob^{-1} (g)	Test weight (g)
T_1 : Soil application of Nano-K at 25 kg ha^{-1}	16.8	16.8	16.0	34.7	555.4	174.9	32.83
T_2 : Soil application of Nano-K at 20 kg ha^{-1}	16.4	16.4	15.8	34.4	545.8	170.6	30.93
T_3 : Soil application of Nano-K at 15 kg ha^{-1}	16.2	16.4	15.5	33.7	523.9	166.7	30.47
T_4 : Soil application of Nano-K at 10 kg ha^{-1}	15.9	16.3	15.4	32.8	501.4	163.3	30.10
T_5 : Soil application of Nano-K at 05 kg ha^{-1}	15.7	16.2	15.2	31.8	480.2	158.1	29.83
T_6 : Soil application of K_2O at 15 kg ha^{-1} + foliar application of 2500 ppm Nano K	17.9	17.2	16.8	41.3	694.8	188.4	34.80
T_7 : Soil application of K_2O at 15 kg ha^{-1} + foliar application of 2000 ppm Nano-K	17.4	16.9	16.4	38.7	635.4	183.2	33.70
T_8 : Soil application of K_2O at 15 kg ha^{-1} + foliar application of 1500 ppm Nano-K	16.8	16.6	16.1	36.5	585.3	178.4	32.87
T_9 : Soil application of K_2O at 15 kg ha^{-1} + foliar application of 1000 ppm Nano-K	16.2	16.3	15.7	34.9	548.4	172.4	31.67
T_{10} : Recommended dose of fertilizers (150 kg N - 75 kg ha^{-1} P_2O_5 ha^{-1} - 40 kg K_2O ha^{-1})	16.9	16.8	16.1	35.8	577.2	175.7	32.90
S.Em±	0.2	0.1	0.2	0.7	14.3	2.3	0.6
CD at (p=0.05)	0.7	0.4	0.5	2.1	42.4	6.9	1.8

of rows cob^{-1}, number of kernels row^{-1}, number of kernels cob^{-1}, kernels weight cob^{-1} and 100 kernel weight (Table 2). The results are in conformity with the findings of Sirisena *et al*. (2013).

Higher gross return were realized with soil application of K_2O at 15 kg ha^{-1} + foliar application of 2500 ppm Nano-K (Rs.138380 ha^{-1}) followed by soil application of K_2O at 15 kg ha^{-1} + foliar application of 2000 ppm Nano - K (Rs.123454 ha^{-1}) and soil application of Nano-K at 25 kg ha^{-1} (Rs.120673 ha^{-1}) where as, lower gross returns was observed with soil application of Nano-K at 05 kg ha^{-1} (Rs.94101 ha^{-1}). The higher gross return was with soil application of K_2O at 15 kg ha^{-1} + foliar application of 2500 ppm Nano-K was due to higher kernel yield.

TABLE 2

Effect of Nano Potassium fertilizer on kernel yield, stover yield and harvest index of maize during *kharif* 2017

Treatments	Kernel yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Harvest index
T_1 : Soil application of Nano-K at 25 kg ha^{-1}	7832	11019	0.42
T_2 : Soil application of Nano-K at 20 kg ha^{-1}	7634	10370	0.42
T_3 : Soil application of Nano-K at 15 kg ha^{-1}	7201	10185	0.41
T_4 : Soil application of Nano-K at 10 kg ha^{-1}	7083	10139	0.41
T_5 : Soil application of Nano-K at 05 kg ha^{-1}	6060	9259	0.40
T_6 : Soil application of K_2O at 15 kg ha^{-1} + foliar application of 2500 ppm Nano-K	9051	11667	0.44
T_7 : Soil application of K_2O at 15 kg ha^{-1} + foliar application of 2000 ppm Nano-K	8028	11065	0.42
T_8 : Soil application of K_2O at 15 kg ha^{-1} + foliar application of 1500 ppm Nano-K	7319	10833	0.40
T_9 : Soil application of K_2O at 15 kg ha^{-1} + foliar application of 1000 ppm Nano-K	7241	10787	0.40
T_{10}: Recommended dose of fertilizers (150 kg N - 75 kg ha^{-1} P_2O_5 ha^{-1} - 40 kg K_20 ha^{-1})	7595	11065	0.41
S.Em±	265	245	0.01
CD (p = 0.05)	787	727	NS

TABLE 3

Effect of Nano Potassium fertilizer on economics of maize during *kharif* 2017

Treatments	Cost of cultivation (Rs. ha^{-1})	Gross returns (Rs. ha^{-1})	Net returns (Rs. ha^{-1})	B:C
T_1 : Soil application of Nano-K at 25 kg ha^{-1}	63292	120673	57381	1.91
T_2 : Soil application of Nano-K at 20 kg ha^{-1}	56476	117250	60774	2.08
T_3 : Soil application of Nano-K at 15 kg ha^{-}	49564	111004	61440	2.24
T_4 : Soil application of Nano-K at 10 kg ha^{-1}	42652	109306	66654	2.56
T_5 : Soil application of Nano-K at 05 kg ha^{-1}	35836	94101	58265	2.63
T_6 : Soil application of K_2O at 15 kg ha^{-1} + foliar application of 2500 ppm Nano-K	50140	138380	88240	2.76
T_7 : Soil application of K_2O at 15 kg ha^{-1} + foliar application of 2000 ppm Nano-K	45916	123454	77538	2.69
T_8 : Soil application of K_2O at 15 kg ha^{-1} + foliar application of 1500 ppm Nano-K	41692	113305	71613	2.72
T_9 : Soil application of K_2O at 15 kg ha^{-1} + foliar application of 1000 ppm Nano-K	37468	112157	74689	2.99
T_{10}: Recommended dose of fertilizers (150 kg N - 75 kg ha^{-1} P_2O_5 ha^{-1} - 40 kg K_20 ha^{-1})	29215	117393	88178	4.02

Higher net return were noted with in soil application of K_2O at 15 kg ha^{-1} + foliar application of 2500 ppm Nano-K (Rs.88240 ha^{-1}) followed by RDF as per package of practices (Rs.88178 kg ha^{-1}) and soil application of K_2O at 15 kg ha^{-1} + foliar application of 2000 ppm Nano-K (Rs.77538 ha^{-1}). However, lower net return was recorded with soil application of Nano-K at 25 kg ha^{-1} (Rs.57381 ha^{-1}) as depicted in Table 3.

The higher net return noticed with soil application of K_2O at 15 kg ha^{-1} + foliar application of 2500 ppm Nano-K (Rs.88240 ha^{-1}) was mainly attributed to higher kernel yield as compared to other treatments. The benefit cost ratio (B:C) varied among the treatments to treatments and ranged from 1.91-4.02 higher profit per rupee invested was with RDF as per package of practices (4.02) followed by soil application of K_2O at 15 kg ha^{-1} + foliar application of 1000 ppm Nano-K (2.99). However, lower B:C was observed in soil application of Nano K at 25 kg ha^{-1} (1.91). Higher profit per rupee invested was recorded with RDF as per package of practices (4.02) and was due to optimum kernel yield and lower cost of cultivation. Lower B:C ratio observed with soil application of Nano-K at 25 kg ha^{-1} (1.91), because of higher cost of Nano-K.

The study clearly indicated that despite increased kernel and stover yields with soil application of K_2O at 15 kg ha^{-1} + foliar application of 2500 ppm Nano-K, higher B:C ratio (4.02) was realized with RDF.

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