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Evaluation of the effectiveness of waste mica and poultry manure as potassium sources on maize in comparison to Muriate of Potash in soil fertilization

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ABSTRACT

This study investigates the potential of waste mica and poultry manure as alternative potassium sources in soil fertilization, compared to the conventional use of muriate of potash (KCl). Potassium is an essential nutrient for plant growth, and its traditional supply from muriate of potash has environmental and economic drawbacks. Utilizing waste mica and poultry manure could offer sustainable and cost-effective alternatives. A field experiment was conducted in a randomized block design (RBD) to evaluate the effectiveness of these materials on crop yield and soil health. Soil was treated with varying proportions of waste mica, poultry manure, and muriate of potash. Key parameters such as soil macronutrient content, crop yield were monitored and analyzed. The results indicated that treatment with 100% RDK through MOP showed the highest kernal yield, stover yield and available potassium. The treatments with 75% RDK through MOP + 25% through Poultry manure and treatment with 75% RDK through MOP + 25% through waste mica were found to be on par with 100% RDK through MOP. The results demonstrated that both waste mica and poultry manure significantly improved soil potassium levels and crop yield, showing their potential as viable potassium sources. The combination of these alternative materials with muriate of potash yielded optimal results, suggesting a synergistic effect. Additionally, the use of poultry manure enhanced soil, contributing to overall soil health. This study highlights the potential benefits of integrating waste mica and poultry manure into conventional fertilization practices. Such an approach not only addresses the disposal issues of waste mica and poultry manure but also promotes sustainable agriculture by reducing reliance on synthetic fertilizers.

Key words: *Muriate of potash, Poultry manure, Potassium and Waste mica.*

Maize (*Zea mays* L.) is India's third most cereal crop after rice and wheat. It is the most versatile emerging crop having wider adaptability under varied agro-climatic conditions. It is one of the important foods, green forage and industrial crops of the world. Maize is called the queen of cereals as it has the highest genetic yield potential among cereals.

Potassium is the third most essential primary macronutrient and it plays a vital role in plant growth and development. Potassium is required in large quantities by most crops. It acts as an activator of enzymes. The element exerts balancing effects on nitrogen and phosphorous (Maqsood *et al*., 2013). In Indian soils, potassium content varies from 0.5 to 3.0%. The average total K content in Indian soils is 1.52% (Mengel and Kirkby, 1987). The total K reserve in soil appears to be sufficient but it lacks in reflection in available potassium.

Generally, a major portion of soil K is in mineral form (Sparks and Huang, 1985). Hence soil fails to supply sufficient amounts of potassium to plants. Only 1-2 per cent of the potassium in soil is readily available to plants. The required amount of K in the soil can be maintained either utilizing the reserve K or by an external supply of K-fertilizers (Wang *et al*., 2000). The primary sources of potassium-bearing minerals in soils are feldspar, micas like (muscovite, biotite and phlogopite), zeolite, gluconite, potassium-taranakite, illite, vermiculite and chlorite (Basak *et al*., 2017). The commercial fertilizers that are being used are prepared from these K-rich minerals. In the last few years, the price of commercial K-fertilizers in many countries increased many-folds especially muriate of potash (MOP). This is due to the lack of potassium ore deposits suitable for manufacturing conventional K-fertilizers namely muriate of potash (MOP) and sulphate of potash (SOP), and the countries are totally dependent on imports from foreign countries (Basak *et al*., 2018). On the other hand, the non-judicious application of inorganic N-fertilizers and the decrease in the use of P and K-fertilizers by peasant communities due to excessive price hikes as well as preference to high yielding varieties put soil health at stake (Meena *et al.,* 2015). To tackle this situation of K demand alternative K sources like waste mica along with organic fertilizers like poultry manure and also Multi-K are found effective.

Mica is a muscovite-type mineral with potassium between 2:1 type aluminosilicate crystal layers. It contains a significant amount of K (8-10%) and could be used as a source of K in agricultural production. The K atoms in inter-lattice space are susceptible to weathering and are mobilized into soil solution due to physical weathering and by the action of soil-borne K-solubilizing microorganisms (Basak *et al*., 2017). The rising cost of inorganic fertilizers coupled with their inability to condition the soil has directed attention to identify alternate sources of potassium. In recent times, poultry manure has gained attention as a potential source of organic fertilizer due to its high nutrient content and relatively low cost. Poultry manure which is rich in nitrogen, phosphorous, potassium and other essential nutrients, has been shown to improve soil fertility, increase crop yield, and enhance the quality of agricultural products.

MATERIAL AND METHODS

A field experiment entitled "Potassium sources and their effects on K use efficiency in maize grown on K-rich soils" was carried out during *rabi*, 2023-24 at the Agricultural College Farm, Bapatla, with a view to study the performance of maize in terms of yield, available nutrient status. The soil of the experimental site was sandy clay loam in texture, slightly alkaline, non-saline, low in organic carbon (0.36%), available nitrogen (220 kg ha^{-1}), available phosphorus (50.7 kg P_2O_5 ha^{-1}) and available potassium (305 kg K_2O ha^{-1}). Maize crop was grown and management practices were followed according to recommendations. The experiment was laid out in Randomized Block Design (RBD) T_1: 0% RDK; T_2: 100% RDK through MOP, T_3: 100% RDK through waste mica; T_4: 100% RDK through poultry manure; T_5: 50% RDK through MOP + 50% through waste mica; T_6: 50% RDK through MOP + 50% through poultry manure; T_7: 75% RDK through MOP + 25% through waste mica; T_8: 75% RDK through MOP + 25% through poultry manure; T_9: 25% RDK through MOP + 75% through waste mica + 1% foliar spray through Multi-K at tasseling stage; T_{10}: 25% RDK through MOP + 75% through poultry manure + 1% foliar spray through Multi-K at tasseling stage.

Well decomposed farmyard manure @ 10 t ha^{-1} was applied 15 days before sowing. Recommended dose of nitrogen and phosphorus were supplied through urea, single super phosphate (SSP), respectively. Recommended dose of potassium was supplied through muriate of potash (MOP), Mica Waste and Poultry Manure. Recommended dose of nitrogen @ 220 kg ha^{-1} and phosphorous @ 80 kg ha^{-1} were applied uniformly to all the plots along with potassium. Recommended dose of potassium @ 80 kg ha^{-1} was applied as per the treatments. Nitrogen was applied in three equal splits (1/3rd each at the time of sowing, knee height and tasseling stages). Phosphorous was applied as basal two days before sowing. Farmyard manure was mixed with biofertilizers *viz.,* KRB@ 1.25 L ha^{-1} and applied uniformly to all the treatments.

Soil analysis involved measuring available nutrient content (nitrogen, phosphorus, potassium) was determined using standard chemical methods. Data were statistically analyzed to evaluate the effects of different treatments on soil properties and plant performance, with significant differences assessed using Tukey's HSD test at a 5% significance level. Quality control measures included instrument calibration, use of standard reference materials, and repeated measurements to ensure accuracy and reliability.

RESULTS AND DISCUSSION

Available macronutrients

The results pertaining to N, P, K at the harvest stage is presented in table 1. The results indicated that available nitrogen and phosphorous were found be significantly higher in the treatment plots where poultry manure was applied. This might be due the application of poultry manure which is a rich source of nutrients. The highest N and were found in treatment T_4: 100% RDK through poultry manure. Comparably, greater N in integrated treatments can result from combining inorganic and organic fertilizers, which accelerated mineralization because of the low

Table 1 Effect of different sources of potassium available N, P, K (kg ha^{-1}) at harvest stage of maize

Treatment	Available N, P, K (kg ha^{-1})		
	Nitrogen	Phosphorous	Potassium
T_1 - 0% RDK	197	49.8	247
T_2 - 100% RDK through MOP	221	52	339
T_3 - 100% RDK through WM	204	50.4	287
T_4 - 100% RDK through PM	275	59.9	279
T_5 - 50% RDK MOP + 50% through WM	219	51.3	319
T_6 - 50% RDK MOP + 50% through PM	249	54.1	310
T_7 - 75% RDK MOP + 25% through WM	214	50.9	327
T_8 - 75% RDK MOP + 25% through PM	233	52.7	335
T_9 - 25% RDK MOP + 75% through WM +1% Foliar spray with Multi-K at tasseling stage	237	51.6	297
T_{10} - 25% RDK MOP + 75% through PM +1% Foliar spray with Multi-K at tasseling stage	258	56.4	301
SEm (±)	10.8	2.19	9.15
CD (p=0.05)	32	6.51	27.2
CV (%)	8.08	7.17	7.52

MOP: Muriate of Potash, WM: Waste mica. PM: Poultry manure

C/N ratio. This result is in agreement with Ayeni and Adetunji (2010) who reported poultry manure and their combinations with NPK fertilizer increased soil OM, N, P and K in soil. An increase in the soil available P in 100% PM treatments may be due to the mineralisation of organic P and the production of organic acids that make soil P more available and reduces P fixation. This result supports the conclusions of Islam *et al*. (2013), who said that higher values of available P will be achieved in soils treated with either organic or inorganic fertilizers, or a combination of these fertilizers, as compared to the control treatments.

The highest available potassium was recorded in the treatment with 100% RDK through MOP (T_2). This is mainly due to highly soluble inorganic fertilizer which is a direct source of potassium which becomes available to crop easily. The treatments with T_7: 75% RDK through MOP + 25% through waste mica and T_8: 75% RDK through MOP + 25% through poultry manure were found to be on par with treatment T_2.

Table: 2. Effect of different sources of potassium on yield of maize

Treatment	Kernel (kg ha^{-1})	Stover (kg ha^{-1})
T_1 - 0% RDK	5850	8029
T_2 - 100% RDK through MOP	7123	9891
T_3 - 100% RDK through WM	6163	8182
T_4 - 100% RDK through PM	6225	8290
T_5 - 50% RDK MOP + 50% through WM	6440	8838
T_6 - 50% RDK MOP + 50% through PM	6549	8949
T_7 - 75% RDK MOP + 25% through WM	6605	9640
T_8 - 75% RDK MOP + 25% through PM	6710	9775
T_9 - 25% RDK MOP + 75% through WM +1% Foliar spray with Multi-K at tasseling stage	6298	8638
T_{10} - 25% RDK MOP + 75% through PM +1% Foliar spray with Multi-K at tasseling stage	6362	8732
SEm (±)	186	261
CD (p=0.05)	556	776
CV (%)	7.1	7.1

The results indicating the kernel yield and stover yield was shown the table 2. The highest kernel yield and stover yield were recorded in treatment 100% RDK through MOP (T_2) and the treatments with T_7: 75% RDK through MOP + 25% through waste mica and T_8: 75% RDK through MOP + 25% through poultry manure were found to be on par with treatment T_2. Treatment T_2 showed the highest yield because MOP is the direct source which provides easily. The increase in yield in treatment T_7 and T_8 with Integrated use of fertilizer with organic manures might be due to the absorption of nutrients responsible for increase photosynthate accumulation and high biomass production finally increasing the yield and yield components. The findings are in close agreement and well supported by Ghetiya *et al*. (2018).

CONCLUSION

This study highlights the favorable impact of integrating a complementary dose of chemical fertilizer with poultry manure on maize growth. The combination of these alternative materials with muriate of potash yielded optimal results, suggesting a synergistic effect. In conclusion, while muriate of potash remains a superior potassium source in terms of immediate availability and effectiveness, waste mica and poultry manure present promising alternatives that support sustainable agriculture. Further research and field trials are recommended to refine application techniques and to fully harness the potential of these alternative potassium sources in various agricultural setting.

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