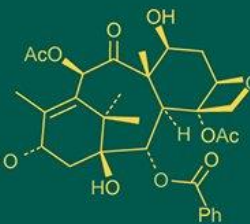
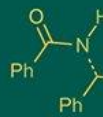


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Effect of Different Levels of Potassium and Molybdenum on Growth and Yield of Maize (*Zea mays* L.)

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Abstract

A field experiment was conducted during *kharif* season 2025 at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences. To determine “Effect of Different Levels of Potassium and Molybdenum on Growth and Yield of Maize (*Zea mays* L.)”. The experiment was laid out in a Randomized Block Design with 10 treatments and replicated thrice. The result revealed that Treatment - 9 (Potassium 60 kg/ha and Molybdenum 50 g/ha) recorded significantly higher Plant height (127.08 cm), Plant dry weight (116.16 g/plant), Significantly maximum number of cobs/plant (3.2), number of row/cob (16.0), number of grains/row (42.73), Test weight (20.35 g), cob length (18.61 cm), cob yield (10.36 t/ha), grain yield (7.40 t/ha) and stover yield (15.13 t/ha) were recorded in treatment 9 (Potassium 60 kg/ha and Molybdenum 50 g/ha).

Keywords: Maize, potassium, molybdenum, growth and yield

Introduction

Maize provides food, feed, fodder and serves as a source of basic raw material for a number of industrial products viz, starch, protein, oil, alcoholic beverages, food sweeteners, cosmetics, bio-fuel, etc. Maize is the third most important food grain in India after wheat and rice and it is cultivated over approximately 11- 12 mha area with an annual production of 43.4 million metric tonnes (mmt) and an average productivity of 3.7 t/ha to 4.0 t/ha (Maize in 2025 as per APEDA data). It was introduced in India during the 16th century by the Portuguese. The United States is the largest producer of maize oil. Brazil, China, Romania, countries of the former Soviet Union, former Yugoslavia and South Africa also produce maize oil (Erenstein *et al.* 2022) ^[3]. It is a co-product of wet and dry milling industries, which essentially breaks down maize into starch, oil, protein and some of the important vitamins and minerals (Gupta *et al.* 2016) ^[5]. Maize oil contains a high proportion of unsaturated fatty acids, of which nearly 78-82% is linoleic acid, an essential fatty acid important for human nutrition. Linoleic acid plays a significant role in lowering harmful cholesterol levels, maintaining elasticity of blood vessels, improving cardiovascular health, and reducing the risk of atherosclerosis (Sharma and Verma, 2021) ^[22]. Apart from linoleic acid, maize oil is also enriched with beneficial compounds such as phytosterols, vitamin E, tocopherols, and other bioactive nutrients that contribute to better human health. Maize oil possesses approximately 2.2 times higher calorific value per unit weight compared to starch, thereby increasing the overall energy value of maize grains. The majority of oil is concentrated in the germ portion of the kernel. In normal maize, the germ contains around 28-32% oil, whereas in high-oil maize genotypes the oil concentration may reach up to 48-52% (Kumar *et al.* 2020) ^[10]. High-oil maize lines are also reported to possess improved protein quality with relatively higher lysine content and greater concentration of yellow pigments such as carotenoids and xanthophylls, which are important for poultry feed and human nutrition. In addition, high-oil maize contains elevated levels of vitamin E (tocopherol), a natural antioxidant that protects fatty acids from oxidative damage and enhances the storage stability and shelf life of maize oil (Patel and Singh, 2022) ^[15]. In recent years, greater emphasis has been placed on the exploitation of heterosis for quality traits such as oil and starch content. During 2023-2025, several private seed companies in India initiated breeding programmes

focusing on specialty maize hybrids including high-oil and quality protein maize hybrids. Recent studies comparing oil accumulation patterns in high-oil and normal maize inbred lines revealed that high-oil genotypes accumulate oil more rapidly during 18–45 days after pollination, resulting in significantly higher final oil content in the kernels (Reddy *et al.* 2024) ^[20]. In the Indian context, maize occupies an important position among cereal crops and ranks third after rice and wheat in terms of area and production (Kalyanasundaram and Augustine, 2021) ^[7]. It is cultivated in diverse agro-ecological regions ranging from the Himalayan foothills to the tropical plains. The crop is grown during different seasons, namely Kharif, Rabi, and Zaid, depending upon regional climatic conditions (Adhikary *et al.* 2020) ^[1]. The increasing demand for maize in the poultry feed industry and its growing industrial applications have led to a steady rise in its cultivation (Singh *et al.* 2026) ^[25]. Furthermore, maize has emerged as a profitable crop for farmers due to its relatively short duration, high yield potential, and suitability for mechanized farming (Ramesh *et al.* 2023) ^[18]. The adoption of hybrid varieties and improved agronomic practices has significantly enhanced maize productivity in recent years (Khushboo and Nirmali, 2024) ^[8]. The growth and development of maize are largely influenced by climatic factors. Being a warm-season crop, maize requires a temperature range of 18 °C to 27 °C for optimal growth and development (Wang *et al.* 2023) ^[27]. It performs well under conditions of adequate sunlight and moderate rainfall. The crop generally requires about 500 to 800 mm of rainfall during its growing period; however, the distribution of rainfall plays a more critical role than the total quantity (Meena *et al.* 2025) ^[14].

Potassium has also been referred to as the ‘quality nutrient’. The quality effects are more closely linked to its interactions with nutrients such as nitrogen, than to absolute levels of K. Increasing the dose of K increases the K uptake by plants due to increase in interaction of K ions and roots of plants with increasing K availability in soil. Potassium levels increase the shoot contents of N, P, K, Ca, S and Zn in the plants due to its stimulation of root and shoot growth (Filho *et al.*, 2017) ^[4]. Well-developed root systems have the ability to exploit a greater soil volume, which is fundamental principle for increasing the contact between roots and nutrients, resulting in an improvement in nutrient uptake (Kumar *et al.* 2024) ^[11].

Molybdenum (Mo) is a trace element found in the soil and is required for optimum growth of plants. Despite its low availability, Mo ranks 53rd in the earth's crust. Compared to many other micronutrients, Potassium is more readily available for biological processes because other metals are often present in chemical forms that are difficult for plants to assimilate (Xiong *et al.* 2017) ^[28]. Recent investigations demonstrated that Potassium supplementation improved chlorophyll content, root development, photosynthetic efficiency, and biomass accumulation in crops exposed to drought and cadmium stress (Zahedi *et al.* 2024) ^[30].

Materials and Method

This experiment was carried out during *kharif* 2025 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj, (U.P), to check the Effect of Different Levels of Potassium and Molybdenum on growth and yield of Maize. The experimental field soil was sandy loam with less availability of nitrogen. The experiment was laid out in

randomised block design consisting of ten treatment viz (T1 Potassium 40 kg/ha + Molybdenum 30 g/ha), (T2 Potassium 40 kg/ha + Molybdenum 40 g/ha), (T3 Potassium 40 kg/ha + Molybdenum 50 g/ha), (T4 Potassium 50 kg/ha + Molybdenum 30 g/ha), (T5 Potassium 50 kg/ha + Molybdenum 40 g/ha), (T6 Potassium 50 kg/ha + Molybdenum 50 g/ha), (T7 Potassium 60 kg/ha + Molybdenum 30 g/ha), (T8 Potassium 60 kg/ha + Molybdenum 40 g/ha), (T9 Potassium 60 kg/ha + Molybdenum 50 g/ha), (T10 N-P-K (120-60-40Kg/ha)). Which were replicated thrice. 2.5 kg/ha seed of Maize variety *GI-5542* the spacing adopted was plant to plant 45 cm and row to 15 cm according to the treatment details and the seeds were drilled at 4-5 cm depth in the net plot area 3m x 3m on 11th August 2025.

The observation on growth parameters i.e. Plant height (cm), Plant dry weight (g), were recorder whereas yield attributing parameters i.e. Number of cobs/plant, Number of cobs/plant, Test Weight (g), Cob yield (kg/ha), Grain yield (kg/ha) and Harvest Index (%) from the net plot area these observation were recorded. The seed and stover yield were taken for the net plot of 1m² and using this formula (economic yield /Biological yield) x 100 then calculate for 1 ha harvest index is calculated. The recorded data were analysed statically by ANOVA technique.

Result and Discussion

Growth Parameters Plant Height

At 100 DAS there was significant difference among the treatments. Significantly higher plant height (127.08 cm) was recorded with the application Potassium 60 kg/ha + Molybdenum 50 g/ha and minimum was reported in Control (RDF) - NPK - 120-60-40 kg/ha (97.00 cm).

However, Potassium 50 kg/ha + Molybdenum 50 g/ha (121.5 cm), Potassium 60 kg/ha + Molybdenum 30 g/ha (122.38 cm) and Potassium 60 kg/ha Molybdenum 40 g/ha (122.44 cm) was statistically at par with Treatment 9.

The significant increase in plant height and dry matter accumulation with potassium at 60 kg/ha may be attributed to its role in osmotic regulation, enzyme activation, photosynthesis and assimilate translocation, which enhanced vegetative growth and biomass production. Similar findings were reported by Reddy *et al.* (2020) ^[19].

The application of molybdenum at 50 g/ha improved growth attributes and dry matter accumulation due to its involvement in nitrogen metabolism, chlorophyll formation and protein synthesis. Enhanced nitrogen use efficiency and nutrient uptake further promoted vigorous plant growth and biomass production, as reported by Kaiser *et al.* (2005) ^[6].

Plant dry weight

At 100 DAS there was significant difference among the treatments. Significantly higher plant dry weight (116.16 g) was recorded with the application Potassium 60 kg/ha + Molybdenum 50 g/ha and minimum was reported in Control (RDF) - NPK - 120-60-40 kg/ha (49.52 g). However, Potassium 60 kg/ha Molybdenum 40 g/ha (107.84 g) was statistically at par with Treatment 9.

The increased dry weight observed with potassium application at 60 kg/ha may be attributed to its role in cell elongation, maintenance of turgor pressure and activation of enzymes involved in photosynthesis and protein synthesis. Potassium also enhances carbohydrate translocation and dry

matter accumulation, resulting in greater biomass production in maize Marschner *et al.* (2012) ^[12].

Higher dry weight with molybdenum application at 50 g/ha may be due to its involvement in nitrogen metabolism through nitrate reductase and nitrogenase enzymes. Improved nitrate assimilation, chlorophyll synthesis and protein formation enhance plant growth and biomass accumulation in maize. Molybdenum also improves nitrogen uptake and utilization, resulting in better crop growth and dry matter production Kovács *et al.* (2015) ^[9].

Yield Parameters

Number of cobs per plant

At harvest significantly higher number of cobs per plant (3.2) was recorded with the application of Potassium 60 kg/ha + Molybdenum 50 g/ha and minimum was reported in Control (RDF) - NPK -120- 60-40 kg/ha (1.2). However, Potassium 60 kg/ha + Molybdenum 40 g/ha (3.0) was statistically at par with Treatment 9.

The significant increase in the number of cobs per plant with potassium application at 60 kg/ha may be attributed to enhanced photosynthesis, enzyme activation and efficient translocation of assimilates to reproductive organs, leading to improved cob formation and reproductive growth in maize. Similar results were reported by Yadav *et al.* (2021) ^[29].

The higher number of cobs per plant with molybdenum application at 50 g/ha might be due to improved nitrogen utilization, enzyme activity and protein synthesis. Enhanced chlorophyll content and photosynthetic efficiency increased assimilate supply to developing cobs, resulting in better cob setting. Similar findings were reported by Kumar *et al.* (2020) ^[10].

Number of row/cob

At harvest significantly higher Maximum number of row/cob (16.0) was recorded with the application of Potassium 60 kg/ha + Molybdenum 50 g/ha and minimum was reported in Control (RDF) - NPK - 120- 60- 40 kg/ha (10.46). However, Potassium 60 kg/ha + Molybdenum 30 g/ha (14.8), Potassium 60 kg/ha + Molybdenum 40 g/ha (15.0) was statistically at par with Treatment 9.

The significant increase in the number of rows per cob with potassium at 60 kg/ha may be attributed to enhanced photosynthetic activity, efficient carbohydrate translocation and improved reproductive growth, resulting in better cob development and grain setting. Similar findings were reported by Patel *et al.* (2019) ^[16].

The increased number of rows per cob with molybdenum at 50 g/ha might be due to improved nitrogen metabolism, protein synthesis and photosynthetic efficiency, which promoted superior cob development and reproductive performance. Similar observations were reported by Singh *et al.* (2021) ^[24].

Number of grains/row

At harvest significantly higher Maximum number of grains/row (42.73) was recorded with the application of Potassium 60 kg/ha + Molybdenum 50 g/ha and minimum was reported in Control (RDF) - NPK -120- 60- 40 kg/ha (28.66). However, Potassium 60 kg/ha + Molybdenum 40 g/ha (39.0) was statistically at par with Treatment 9.

The significant increase in the number of grains per row with potassium application at 60 kg/ha might be attributed to enhanced photosynthetic efficiency, better translocation of carbohydrates and improved grain setting, which ensured a continuous supply of assimilates to developing grains. Similar findings were reported by Verma *et al.* (2020) ^[26].

The increase in the number of grains per row with molybdenum application at 50 g/ha might be due to improved nitrogen metabolism, enzyme activity and nutrient utilization, leading to better grain formation and development in maize. Similar observations were reported by Sharma *et al.* (2022) ^[23].

Test weight

At harvest the significantly higher maximum Test weight (20.35 g) was observed in (treatment 9) Potassium 60 kg/ha + Molybdenum 50 g/ha compared to the control (18.09 g). Whereas Potassium 60 kg/ha + Molybdenum 30 g/ha (19.76 g), Potassium 60 kg/ha + Molybdenum 40 g/ha (19.93 g). Correspondingly found to be statically at par with (treatment 9).

The significant increase in test weight with potassium application at 60 kg/ha might be attributed to enhanced photosynthetic activity, efficient translocation of assimilates and improved grain filling, resulting in heavier and well-developed grains. Similarly, molybdenum application at 50 g/ha might have increased test weight through improved nitrogen metabolism, protein synthesis and chlorophyll formation, which enhanced grain development and dry matter accumulation. These observations corroborate the findings.

Cob length

At harvest the significantly higher cob length (18.61) was recorded with the application of Potassium 60 kg/ha + Molybdenum 50 g/ha and minimum was reported in Control (RDF)- NPK-120- 60- 40 kg/ha (11.15). However, Potassium 50 kg/ha + Molybdenum 50 g/ha (17.46), Potassium 60 kg/ha + Molybdenum 30 g/ha (17.65), Potassium 60 kg/ha + Molybdenum 40 g/ha (17.93) were statistically at par with Treatment 9.

The increased cob length with potassium application at 60 kg/ha might be attributed to enhanced photosynthetic activity, efficient carbohydrate translocation and improved cell elongation, which promoted better cob growth and development. Similar findings were reported by Verma *et al.* (2020) ^[26].

Molybdenum application at 50 g/ha might have increased cob length through improved nitrogen metabolism, protein synthesis and enzymatic activity, resulting in better reproductive growth and cob development. Similar observations were reported by Kumar *et al.* (2020) ^[10].

Cob yield (t/ha)

At harvest the significantly higher cob yield (10.36 t/ha) was recorded with the application of Potassium 60 kg/ha + Molybdenum 50 g/ha and minimum was reported in Control (RDF) - NPK - 120- 60- 40 kg/ha (6.22 t/ha) However, Potassium 60 kg/ha + Molybdenum 40 g/ha (8.65 t/ha) was statistically at par with Treatment 9.

Further, the higher cob yield with potassium application at 60 kg/ha might be attributed to enhanced photosynthetic efficiency, improved translocation of assimilates and better cob development. Adequate potassium nutrition ensured

efficient utilization of nutrients and greater accumulation of dry matter in cobs, resulting in increased cob yield. Similar findings were reported by Patel *et al.* (2019) ^[16].

Similarly, molybdenum application at 50 g/ha might have increased cob yield through improved nitrogen metabolism, enzyme activity and nutrient use efficiency. Enhanced vegetative growth and reproductive development promoted better cob formation and development, leading to higher cob yield in maize. These findings are in agreement with Kumar *et al.* (2020) ^[10].

Grain yield (t/ha)

At harvest the significantly higher grain yield (7.40 t/ha) was recorded with the application of Potassium 60 kg/ha + Molybdenum 50 g/ha and minimum was reported in Control (RDF)

NPK - 120- 60- 40 kg/ha) (3.02 t/ha) However, Potassium 60 kg/ha + Molybdenum 40 g/ha (6.17) was statistically at par with Treatment 9.

Further, the higher grain yield with potassium application at 60 kg/ha might be attributed to enhanced photosynthetic efficiency, carbohydrate translocation and improved grain filling. Adequate potassium nutrition ensured better assimilate supply to developing grains, resulting in increased grain yield in maize. Similar findings were reported by Choudhary *et al.* (2021) ^[2].

Similarly, molybdenum application at 50 g/ha might have increased grain yield through improved nitrogen metabolism, protein synthesis and nutrient use efficiency.

Enhanced photosynthetic activity and reproductive development promoted better grain setting and grain filling, leading to higher grain yield in maize. Similar observations were reported by Meena *et al.* (2020) ^[13].

Stover yield (t/ha)

At harvest the significantly higher stover yield (15.13 t/ha) was recorded with the application of Potassium 60 kg/ha + Molybdenum 50 g/ha and minimum was reported in Control (RDF)

NPK - 120 60- 40 kg/ha) (8.28 t/ha). However, Potassium 60 kg/ha + Molybdenum 30 g/ha

(14.30 t/ha), Potassium 60 kg/ha + Molybdenum 40 g/ha (14.77 t/ha) was statistically at par with Treatment 9.

Further, the higher stover yield with potassium application at 60 kg/ha might be attributed to enhanced photosynthetic activity, efficient carbohydrate translocation and improved water- use efficiency. These factors promoted vigorous vegetative growth and greater biomass accumulation, resulting in higher stover yield in maize. Similar findings were reported by Saini *et al.* (2020) ^[21].

Similarly, molybdenum application at 50 g/ha might have increased stover yield through improved nitrogen metabolism, protein synthesis and nutrient utilization. Enhanced vegetative growth and dry matter production under adequate molybdenum nutrition contributed to greater biomass accumulation and higher stover yield in maize. Similar observations were reported by Prajapati *et al.* (2022) ^[17].

Table 1: Effect of Different Levels of Potassium and Molybdenum on Growth Attributes of Maize

S.No.	Treatments	Plant Height (cm)	Dry Weight (g/plant)
1	Potassium 40 kg/ha + Molybdenum 30 g/ha	118.00	53.82
2	Potassium 40 kg/ha + Molybdenum 40 g/ha	119.02	55.62
3	Potassium 40 kg/ha + Molybdenum 50 g/ha	119.12	64.23
4.	Potassium 50 kg/ha + Molybdenum 30 g/ha	119.18	72.66
5	Potassium 50 kg/ha + Molybdenum 40 g/ha	119.87	81.4
6	Potassium 50 kg/ha + Molybdenum 50 g/ha	121.5	89.66
7	Potassium 60 kg/ha + Molybdenum 30 g/ha	122.38	98.2
8	Potassium 60 kg/ha + Molybdenum 40 g/ha	122.44	107.84
9	Potassium 60 kg/ha + Molybdenum 50 g/ha	127.08	116.16
120 - 60 - 40 kg/ha N-P-K (Control)		97.00	49.52
F - Test		S	S
S.Em(±)		3.56	3.28
CD (p=0.05)		7.0	8.32

Table 2: Effect of Different Levels of Potassium and Molybdenum on Yield attributes of Maize

S.No.	Treatments	Number of Cobs/plant	Number of row/cob	Number of Grains/row	Test weight (g)	Cob Length (cm)	Cob yield (t/ha)	Grain yield (t/ha)	Stover Yield (t/ha)
1.	Potassium 40 kg/ha + Molybdenum 30 g/ha	1.4	12.4	31.73	18.22	13.35	6.3	4.54	11.12
2.	Potassium 40 kg/ha + Molybdenum 40 g/ha	1.6	13.13	32.46	18.51	13.77	6.45	4.61	12.08
3.	Potassium 40 kg/ha + Molybdenum 50 g/ha	1.6	13.53	33.33	18.89	16.50	6.62	4.72	12.52
4.	Potassium 50 kg/ha + Molybdenum 30 g/ha	2.2	13.73	34.13	18.99	17.17	6.75	4.80	12.82
5.	Potassium 50 kg/ha + Molybdenum 40 g/ha	2.4	14.13	35.73	19.31	17.34	6.96	4.95	13.45
6.	Potassium 50 kg/ha + Molybdenum 50 g/ha	2.2	14.6	37.06	19.67	17.46	7.88	5.66	13.83
7.	Potassium 60 kg/ha + Molybdenum 30 g/ha	2.4	14.8	38.33	19.76	17.65	8.44	6.03	14.30
8.	Potassium 60 kg/ha + Molybdenum 40 g/ha	3.0	15.0	39.0	19.93	17.93	8.65	6.17	14.77
9.	Potassium 60 kg/ha + Molybdenum 50 g/ha	3.2	16.0	42.73	20.35	18.61	10.36	7.40	15.13
10.	120 - 60 - 40 kg/ha N-P-K (Control)	1.2	10.46	28.66	18.09	11.15	6.22	3.02	8.28
F test		S	S	S	S	S	S	S	S
SEm (±)		0.10	0.40	1.30	0.20	0.40	1.41	0.43	0.58
CD (P=0.05)		0.31	1.20	3.87	0.61	1.20	1.73	1.36	1.19

Conclusion

It is concluded that for obtaining higher yield components with better quality of Maize, application of Potassium 60 kg/ha + Molybdenum 50 g/ha was recorded significantly higher plant height (127.08 cm), maximum plant dry weight (116.16 g/plant), and yield attributing parameters higher number of cobs/plant (3.2), number of row/cob (16.0), test weight (20.35 g), cob length (18.61 cm) higher cob yield (10.36 t/ha), and maximum number of grains/row (42.73), higher grain yield (7.40 t/ha), higher stover yield (15.13 t/ha) as compared to other treatments. Since, the findings based on the research done in one season.

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