Original Research Article

Ascertaining Impact of Potassium Schoenite (Mahalaabh) on the Yield and its Attributes in Wheat, Mustard and Onion

Abstract

Climate change and intensive farming necessitate precise nutrient application in agriculture. Potassium, magnesium and sulphur deficiencies impact crop yield and quality, while agrochemical residues pose environmental risks. Mahalaabh ($K_2SO_4 \cdot MgSO_4 \cdot 6H_2O$), a natural and neutral potassium Schoenite compound containing potassium, sulphur and magnesium, addresses these challenges. Field experiments were conducted during the 2023-24 Rabi season at AGROCEL Industries Pvt. Ltd., Mandvi, to ascertain the effects of Mahalaabh on wheat, mustard, and onion using a Randomized Block Design with different application methods and dosages. Mahalaabh improved yields across all crops compared to the RFD and commercial check K-mag. In wheat, drip application at 8 kg/acre increased yield by 31.27%, while foliar application twice at 15 g/L improved yield by 18.10%, due to increased ear length and test weight. For mustard, two applications at 10 kg/acre yielded a 12.75% increase, primarily attributed to more secondary branches, siliqua/plant and seeds/siliqua, with two applications more effective than the single ones. In contrast, single applications of Mahalaabh at 12.5 kg/acre increased onion yields by 29.20% and were comparable to the results obtained from two applications at the same rate (30.97% increase). Mahalaabh Powder proves effective for crop yield improvement, with optimal application methods and dosages varying by crop type.

Keywords: Mahalaabh, Potassium, Wheat, Mustard, Onion

Introduction

Agricultural intensification and climate change threaten food security and environmental sustainability. Climate impacts include altered weather patterns affecting crop productivity. For every 1°C temperature rise, crop yields may decrease by 5-10% (Bibi and Rahman, 2023). A long-term study on *Triticum aestivum* showed drought reduced crop yield by approximately 22% (Semeraro *et al*., 2023). Precise nutrient application tailored to soil and plant needs is crucial for maintaining agricultural output while preserving soil quality.

Deficiencies in potassium, magnesium and sulphur hinder agricultural production. Potassium regulates water and enzyme activity, magnesium is crucial for photosynthesis, while sulphur is essential for protein synthesis. Mahalaabh ($K_2SO_4 \cdot MgSO_4 \cdot 6H_2O$), an ECOCERT-certified organic 3-in-1 water-soluble product, addresses these deficiencies. Potassium schoenite, a component of Mahalaabh, has been reported to improve plant growth and yield in potato (Ghosh *et al*., 2017). Mahalaabh enhances productivity in castor, cotton and groundnut through drip irrigation and foliar application, with optimal dosages varying by crop (Acharya *et al*., 2024). Its low chlorine content suits chlorine-sensitive crops. Therefore, the importance of apposite nutritional product in balanced, crop-specific nutrient management for optimal agricultural productivity cannot be underscored.

Balanced nutrition, as offered by Mahalaabh, is crucial in crops like wheat, mustard and onion that have been afflicted with nutrient deficiencies and abysmal impacts of climate challenges. In wheat, potassium improves grain quality, processing properties, drought and disease resistance and above all nutrient use efficiency (Gu *et al*., 2021; Zörb *et al*., 2014). Magnesium enhances yield, protein content and stress resistance (Gerendás and Führs, 2013), while sulphur boosts yield, baking quality, nitrogen use efficiency and disease resistance (Zhao *et al*., 1999). For mustard, potassium is cardinal for seed yield, oil content, drought tolerance and nutrient use efficiency (Shekhawat *et al*., 2012). Magnesium improves photosynthesis, seed yield, oil quality and stress resistance (Ahmad and Abdin, 2000). Sulphur, key for glucosinolates and amino acids, enhances yield, oil content/quality and nitrogen use efficiency (Malhi and Gill, 2007). In onion, potassium improves bulb size, quality, storage life and disease resistance (Ali and Tanveer, 2019). Magnesium ensures efficient photosynthesis and nutrient transport (Guo *et al*., 2016), while sulphur contributes to flavour, pungency and pest/disease resistance (McGrath *et al*., 1996).

In light of these challenges and the benefits of balanced nutrition, optimizing fertilization strategies is crucial for enhancing crop productivity while ensuring environmental sustainability. Products like Mahalaabh present a promising avenue for achieving this balance. Appreciating this, field trials were conducted at the AGROCEL R&D Farm at Koday, Mandvi during the *rabi* season of 2023-24 to evaluate the efficacy of this balanced nutrient formulation on the yield and yield components of wheat, mustard and onion in the arid region of Kachchh. The results of these trials could provide valuable insights into developing more sustainable and efficient nutrient management strategies in the face of ongoing agricultural and climatic challenges.

Material and Methods

Field experiments were conducted in a Randomized Block Design (RBD) with three replications at AGROCEL Industries Pvt. Ltd. R&D Farm, Koday, Mandvi, Kachchh during the *Rabi* season of 2023-24 to assess the effect of Potassium Schoenite (Mahalaabh) on the growth and yield of wheat (*Triticum aestivum* L.), mustard (*Brassica juncea* L.) and onion (*Allium cepa* L.). Mahalaabh Powder was applied through drip irrigation across wheat, mustard and onion experiments with varying frequencies and timings in addition to crop specific recommended fertilizer dose (RFD). In wheat, two drip applications were performed at 30-35 days after sowing (DAS) and 50-55 DAS. Mustard received either one drip application at 35-40 DAS or two applications at 35-40 DAS and 50-55 DAS. For onion, the drip treatments included one application at 25-30 DAS or two applications at 25-30 DAS and 45-50 DAS. Additionally, foliar spray of Mahalaabh Powder was conducted exclusively in wheat at concentrations of 10 g/L and 15 g/L, applied either once (30-35 DAS) or twice (30-35 and 50-55 DAS). These drip and foliar application treatments were compared against three standard practices; crop-specific basal application of Mahalaabh Granules, the RFD and K-mag application. This comprehensive experimental setup enabled a thorough comparison of the efficacy of drip fertigation and foliar application methods against conventional fertilization techniques across the three crops.

The experiments site represented sandy loam soil with a light brown colour, well-drained and fairly retentive of moisture. The soil was low in available nitrogen, optimum in available phosphorus and medium in available potassium. Nutrition to each crop was given at recommended rate and schedule. All requisite agronomic practices were followed as per the recommended practices for the respective crops. The observations were recorded from five randomly selected tagged plants *viz*., plant height (cm),

effective tillers/plant, ear length (cm), seeds/ear, primary branch/plant, secondary branch/plant, silique/plant, seeds/silique, bulb diameter (mm) and bulb weight (g), test weight (g), grain yield (kg/acre), seed yield (kg/acre) and bulb yield. The data so recorded for various parameters were statistically analysed as per method described by Panse and Sukhatme (1985).

Result and Discussion

Effect of Potassium Schoenite on Wheat

The study on wheat indicate that application of Mahalaabh whether as Mahalaabh Powder through drip and foliar or Mahalaabh Granule as basal dose at 25 kg/acre in addition to RFD was numerically effective in increasing grain yield up to 31.27%, 18.10% and 23.62%, respectively, over 1177 kg/acre in grain yield of RFD (Table 1). Mahalaabh Powder was most effective when applied through drip irrigation at higher dose of 8 kg/acre, yielding 31.27% more grain than RFD. Foliar application was also effective at higher doses at 15 g/L, exhibiting 18.10% and 12.12% higher grain yields than RFD when applied twice (30-35 & 50-55 DAS) and once (30-35 DAS), respectively. Further, two foliar applications consistently outperformed a single application, regardless of dose. The increase in grain yield were attributed to gain in ear length and test weight. Further, Mahalaabh Powder application through drip increased ear length by 8.82% irrespective of dose, while its foliar application at 15 g/L increased the ear length by 3.55% and 4.34% when applied once and twice, respectively. The gain in test weight varied with application rate and method. When applied through drip irrigation, Mahalaabh Powder at 8 kg/acre resulted in a 10.70% increase in test weight, while the 6 kg/acre rate yielded a 4.56% increase over RFD. Foliar application showed more pronounced effects when applied twice irrespective of dose notching 6.09% and 6.74% increase in test weight over RFD in 10 g/L and 15 g/L, respectively.

When compared to the commercial check K-mag yielding 1219 kg/acre, Mahalaabh Powder application exhibited varying degrees of improvement in grain yield and other parameters. When Mahalaabh Powder was applied twice through drip irrigation at 8 kg/acre, it resulted in a 26.74% increase in grain yield, while the 6 kg/acre rate yielded a 9.84% increase. Two foliar applications also evinced improvements with 10 g/L and 15 g/L concentration increasing grain yield by 13.86% and 14.03%, respectively. Ear length consistently increased by 6.03% with drip irrigation, regardless of the dosage applied. The comparative gain in test weight to K-mag basal application at 25 kg/acre varied with application method and concentration. Drip irrigation at 8 kg/acre led to a 10.89% increase in test weight, while 6 kg/acre resulted in a 4.74% increase. Foliar application at 15 g/L increased test weight by 6.10% and 6.91% when applied once and twice, respectively, while 10 g/L when applied twice yielded a 6.27% increase in test weight. Mahalaabh Powder at 8 kg/acre applied twice through drip irrigation was the only treatment to outperform Mahalaabh Granules at 25 kg/acre basal application (1455 kg/acre) by 6.19%, with corresponding increases in ear length (4.29%) and test weight (2.07%). In consonance to present findings, Acharya et al. (2024) has reported conspicuous benefits of Mahalaabh application in quantitative improvements of yield and its attributes in cotton, castor and groundnut. Vijayakumar *et al*. (2019), Singh *et al*. (2019) and Gupta *et al*. (2020) have also reported advantages of potassium application through different sources in wheat.

Thus, Mahalaabh application, regardless of formulation, improved grain yield over RFD by 7.56% to 31.27%. The most effective method was drip application of

Mahalaabh Powder at 8 kg/acre, which increased yield by 31.27% compared to RFD. Foliar application at 15 g/L applied twice and once increased yields by 18.10% and 12.12%, respectively. These yield improvements were primarily attributed to increases in ear length and test weight.

Effect of Potassium Schoenite on Mustard

Mahalaabh application demonstrated numerical yield improvements across various formulations (Table 2). Yield enhancements due to Mahalaabh Powder application through drip over the RFD ranged from 2.15% with a single application of 10kg/acre at 35-40 DAS to 12.75% with two applications of the same dose at 35-40 DAS and 50-55 DAS. Thus, the most effective treatment of Mahalaabh Powder appeared to be two applications at 10kg/acre. Further, two applications of 8 kg/acre and 12.5 kg/acre through drip irrigation following the same schedule increased seed yield by 7.11% and 7.92%, respectively. The improved seed yield was primarily attributed to increased plant growth and reproductive parameters. Secondary branches per plant increased by 24.54%, 21.05% and 20.59% with two applications at the rate of 10 kg/acre, 12.5 kg/acre and 8 kg/acre respectively, compared to respective increase of 8.36%, 16.25% and 12.30% with single application. Similarly, siliqua/plant showed better improvements with two applications, increasing by 8.62%, 7.62% and 7.15% for 10 kg/acre, 12.5 kg/acre and 8 kg/acre, compared to respective increase of 1.86%, 7.46% and 4.29% increases with single application. Seeds/siliqua increased by 13.70%, 12.49% and 9.97% with two applications at 10 kg/acre, 12.5 kg/acre and 8 kg/acre as compared to respective increase of 1.62%, 6.99% and 4.29% increases with single application. These results consistently demonstrated that two applications of Mahalaabh Powder through drip, particularly at 10 kg/acre, outperformed single applications across various growth and yield parameters. Similar results with potassium application from different sources have been reported by Lakhan *et al*. (2017) and Lucy Taki and Lalrinengi (2021).

Comparing impacts of Mahalaabh Powder to K-mag revealed that two applications at 10kg/acre, 12.5 kg/acre and 8 kg/acre outperformed K-mag (765 kg/acre), yielding 9.80%, 5.10% and 4.31% higher, respectively. In contrast, single application at these doses showed more modest improvements of 0.52%, 3.27% and 0.26% over K Mag. Generally, all Mahalaabh treatments, except for the single application at 10 kg/acre, demonstrated increases in yield components compared to K Mag. However, no Mahalaabh Powder treatment surpassed the performance of Mahalaabh Granules applied as a basal dose at 25 kg/acre. Thus, it can be concluded that two applications of Mahalaabh Powder at 10 kg/acre appeared most effective, yielding 12.75% higher than the RFD.

Effect of Potassium Schoenite on Onion

In onion, all drip-applied Mahalaabh Powder treatments effectively increased bulb yield compared to the RFD (11.85 tons/acre). Yield improvements ranged from 5.40% with a single application of 8 kg/acre at 25-30 DAS to 30.97% with two applications of 12.5 kg/acre at 25-30 DAS and 45-50 DAS. Notably, single application at higher rates proved nearly as effective as double application. One application at 10 kg/acre and 12.5 kg/acre increased bulb yield by 27.76% and 29.20% over RFD, respectively, compared to 29.45% and 30.97% for two applications at the same rates.

The increased bulb yield was primarily due to gains in bulb weight, which improved from 9.37% with a single 8 kg/acre application to 28.33% with two 12.5 kg/acre applications. Bulb diameter improvements were less consistent, with the best results

seen in two applications at higher rates at 10 kg/acre as 7.01% and 8.60% at 12.5 kg/acre over RFD. Similar results with potassium application have been reported by Rani and Jha (2018) and Kumara *et al*. (2018).

Compared to K-mag that yielded 13.53 tons/acre, all Mahalaabh Powder treatments except the single 8 kg/acre application showed yield increases ranging from 11.90% (10 kg/acre applied once) to 14.71% (12.5 kg/acre applied twice). Bulb weight increases were more pronounced with two applications (13.28% to 23.23%) than with one (4.28% to 12.52%). Similarly, bulb diameter improvements over K-mag ranged from 0.91% to 9.24% with two applications, compared to 0.41% to 2.80% with single applications.

In conclusion, single applications of Mahalaabh Powder at higher rates (10 kg/acre and 12.5 kg/acre) proved highly effective in onion, yielding 27.76% and 29.20% increases over RFD, respectively. These results were comparable to the yield increases observed with two applications at the same rates (29.45% and 30.97%) and were similar to the performance of Mahalaabh Granules applied as basal at 50 kg/acre.

Conclusion

It can be concluded that Mahalaabh Powder application improved grain yield across all tested crops. In wheat, drip application of Mahalaabh Powder at 8 kg/acre increased yield by 31.27%, while foliar application at 15 g/L applied twice increased yield by 18.10%. These improvements were primarily due to increased ear length and test weight. For mustard, two applications of Mahalaabh Powder at 10 kg/acre yielded a 12.75% increase in seed yield, attributed to increased secondary branches per plant, siliqua/plant, and seeds/siliqua. Two applications were more effective than a single application. In onion, a single application of Mahalaabh Powder at 12.5 kg/acre resulted in a 29.20% yield increase, comparable to the 30.97% increase with two applications at the same rate. Mahalaabh Granules applied as basal at 50 kg/acre showed similar performance. These findings suggest that Mahalaabh is an effective nutrient supplement for improving crop yields, with optimal application methods and dosages varying by crop type.

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Table 1. Impact of potassium schoenite (Mahalaabh) on growth, yield and yield attributing characters of Wheat

Tr. No.	Treatment details	Plant Height (cm)	Efffective tillers/ Pl.	Ear length (cm)	Seeds/ Ear	Test Wt (g)	Grain yield (kg/Acre)
T1	RFD + MLP 6 kg/acre at 30-35 & 50-55 DAS through Drip	75.13	4.47	8.27	32.20	43.78	1339
T2	RFD + MLP 8 kg/acre at 30-35 & 50-55 DAS through Drip	78.67	5.47	8.27	34.47	46.35	1545
T3	RFD + MLP 10 g/L at 30-35 DAS as foliar	72.33	4.87	7.80	31.53	42.84	1266
T4	RFD + MLP 10 g/L at 30-35 & 50-55 DAS as foliar	76.00	5.00	7.87	33.00	44.42	1388
T5	RFD + MLP 15 g/L at 30-35 DAS as foliar	76.20	5.20	7.87	33.87	44.35	1322
T6	RFD + MLP 15 g/L at 30-35 & 50-55 DAS as foliar	78.33	5.40	7.93	34.80	44.69	1390
T7	RFD + K-mag 25 kg/acre as basal	72.80	5.27	7.80	32.80	41.80	1219
T8	RFD + Mahalaabh Gr. 25 kg/acre as basal	78.07	5.47	7.93	35.13	45.41	1455
T9	RFD (48:24:16:00 kg NPKS/Acre)	75.47	4.87	7.60	33.73	41.87	1177
S.Em. ±		2.49	0.32	0.15	1.20	2.06	76.34
CD at 5%		NS	NS	NS	NS	NS	NS
CV %		5.69	10.81	7.33	6.21	8.13	9.84

Table 2. Impact of potassium schoenite (Mahalaabh) on growth, yield and yield attributing characters of mustard

Tr. No.	Treatment details	Plant Height (cm)	Primary Br./ Pl.	Secondary Br./ Pl.	Siliqua/ Plant	Seeds/ Siliqua	Test Wt. (g)	Seed yield (kg/Acre)
T1	RFD + MLP 8 kg/acre at 30-35 DAS through Drip	158.53	4.80	17.07	296.60	11.53	4.592	767
T2	RFD + MLP 8 kg/acre at 30-35 & 50-55 DAS through Drip	164.47	4.93	18.33	304.73	11.80	4.693	798
T3	RFD + MLP 10 kg/acre at 30-35 DAS through Drip	155.93	4.73	16.47	289.00	10.93	4.640	761
T4	RFD + MLP 10 kg/acre at 30-35 & 50-55 DAS through Drip	166.53	5.13	18.93	307.73	12.20	4.775	840
T5	RFD + MLP 12.5 kg/acre at 30-35 DAS through Drip	163.20	4.87	17.67	304.27	11.53	4.679	790
T6	RFD + MLP 12.5 kg/acre at 30-35 & 50-55 DAS through Drip	164.53	4.93	18.40	306.20	12.07	4.709	804
T7	RFD + K-mag 25 kg/acre as basal	158.07	4.80	16.67	295.27	11.07	4.635	765
T8	RFD + Mahalaabh Gr. 25 kg/acre as basal	166.73	5.27	19.07	330.13	12.73	4.768	874
T9	RFD (20:20:00:16 kg NPKS/Acre)	155.53	4.53	15.20	284.40	10.73	4.644	745
S.Em. ±		5.23	0.17	0.69	12.16	0.54	0.181	40.89
CD at 5%		NS	NS	NS	2.08	NS	NS	NS
CV %		5.45	5.61	5.89	6.85	6.97	7.99	6.69

Table 3. Impact of potassium schoenite (Mahalaabh) on growth, yield and yield attributing characters of onion

Tr. No.	Treatment details	Bulb diameter (mm)	Bulb Wt. (g)	Bulb yield (t/Acre)
T1	RFD + MLP 8 kg/acre at 25-30 DAS through Drip	60.97	85.87	12.49
T2	RFD + MLP 8 kg/acre at 25-30 & 45-50 DAS through Drip	61.27	98.90	15.32
T3	RFD + MLP 10 kg/acre at 25-30 DAS through Drip	62.42	90.50	15.14
T4	RFD + MLP 10 kg/acre at 25-30 & 45-50 DAS through Drip	65.36	92.83	15.34
T5	RFD + MLP 12.5 kg/acre at 25-30 DAS through Drip	61.52	92.21	15.31
T6	RFD + MLP 12.5 kg/acre at 25-30 & 45-50 DAS through Drip	66.33	100.99	15.52
T7	RFD + K-mag 50 kg/acre as basal	60.72	81.95	13.53
T8	RFD + Mahalaabh Gr. 50 kg/acre as basal	63.31	98.33	15.43
T9	RFD (20:10:08:08 kg NPKS/Acre)	61.08	78.51	11.85
S.Em. ±		3.45	4.64	0.80
CD at 5%		NS	13.90	2.39
CV %		9.56	8.82	9.58

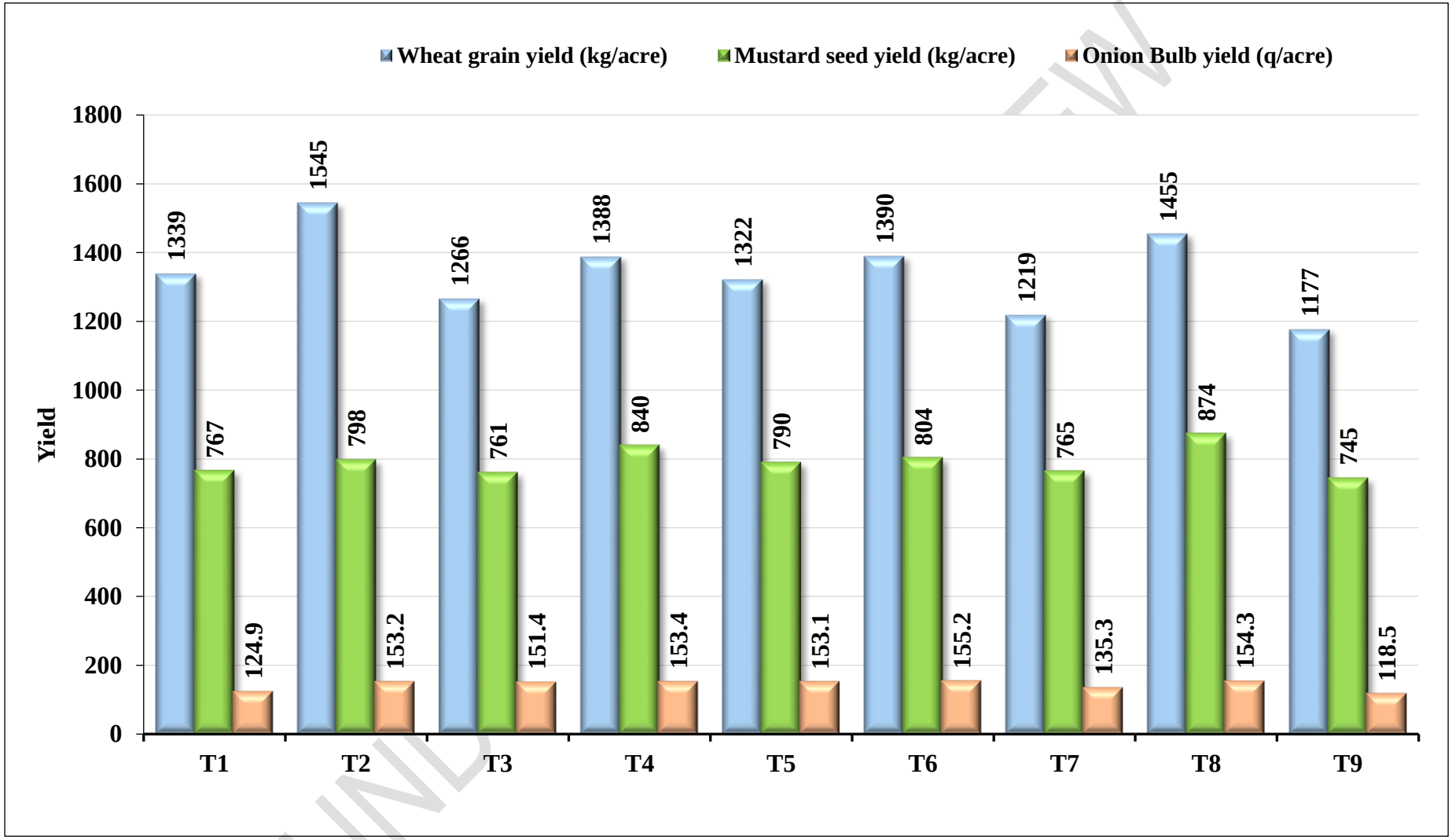

Figure 1: Effect of different Mahalaabh treatments on wheat grain yield, mustard seed yield and onion bulb yield.