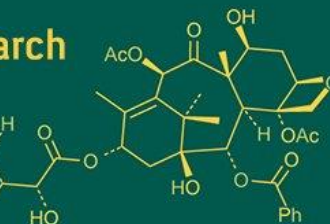
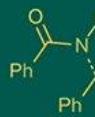


## International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693  
ISSN Online: 2617-4707  
NAAS Rating (2026): 5.29  
IJABR 2026; SP-10(5): 676-681  
[www.biochemjournal.com](http://www.biochemjournal.com)  
Received: 14-03-2026  
Accepted: 17-04-2026

**Suresh Acharya**  
R&D Field, Agrocel Industries  
Pvt. Ltd., Koday, Mandvi,  
Kachchh, Gujarat, India

**Dipika Ganatra**  
R&D Field, Agrocel Industries  
Pvt. Ltd., Koday, Mandvi,  
Kachchh, Gujarat, India

**Rahul Dharaviya**  
R&D Field, Agrocel Industries  
Pvt. Ltd., Koday, Mandvi,  
Kachchh, Gujarat, India

**Dhaval Dharaviya**  
R&D Field, Agrocel Industries  
Pvt. Ltd., Koday, Mandvi,  
Kachchh, Gujarat, India

## Compatibility of MahaBooster plus (Mycorrhizal biofertilizer) with different chemical and specialty fertilizers in wheat

**Suresh Acharya, Dipika Ganatra, Rahul Dharaviya and Dhaval Dharaviya**

**DOI:** <https://www.doi.org/10.33545/26174693.2026.v10.i5Sh.8448>

### Abstract

Field and pot experiments were conducted on wheat to evaluate the compatibility and persistence of MahaBooster Plus, containing AMF and Lateral Root Promoting Peptides (LRPP), applied alone and in combination with conventional chemical fertilizers (Urea, DAP and MoP) and specialty fertilizers (Mahalaabh Granules, Maha Sulfate and Wonder Granules). Sole application of MahaBooster Plus recorded maximum root colonization under field (100%) and pot (80%) conditions at 40 DAS. Combined application with chemical fertilizers caused pronounced initial suppression of AMF colonization, reducing colonization to 20%, whereas specialty fertilizers maintained comparatively higher colonization (60-80%). Among chemical fertilizers, DAP exerted the strongest inhibitory effect, reducing both spore count and recovery in colonization at 60 DAS, indicating phosphate-mediated suppression of AMF activity. In contrast, Urea and MoP showed substantial recovery suggesting that the suppressive effects were largely transient. Specialty fertilizers exhibited greater compatibility with Mahalaabh Granules showing the highest compatibility as indicated by lowest reduction (9.5%) in spore population along with sustained root colonization under both field and pot conditions. Microscopic observations further confirmed progressive establishment of AMF symbiosis over time through increased hyphal density, vesicle formation, and cortical colonization at 60 DAS. Thus, despite conventional chemical fertilizers initially suppress AMF establishment, their inhibitory effects diminish with crop advancement. In contrast, specialty fertilizers, particularly Mahalaabh Granules, supported superior AMF persistence and symbiotic efficiency, highlighting their suitability for sustainably intensive agricultural systems.

**Keywords:** Mycorrhiza, fertilizers, Mahabooster, Mahalaabh, Mahasulfate, wonder granule

### Introduction

Mycorrhizae are among the oldest and most widespread symbiotic associations in terrestrial ecosystems, originating nearly 450-500 million years ago and enabling early plants to survive in nutrient-poor soils (Pirozynski & Malloch, 1975) [1]. Today, nearly 80% of terrestrial plants form associations with Arbuscular Mycorrhizal Fungi (AMF) (Schüßler *et al.*, 2001) [6]. In this mutualistic relationship, plants provide carbohydrates to the fungi, while fungal hyphae extend beyond the root depletion zone and improve the uptake of relatively immobile nutrients such as phosphorus, zinc and copper, along with nitrogen and water (Taylor *et al.*, 1995) [3]. Phosphorus is essential for ATP production and energy transfer, whereas zinc plays a key role in enzyme activity, stomatal regulation, chlorophyll formation and leaf area development. Through improved nutrient and water absorption, AMF enhance root growth, plant vigor, stress tolerance and crop productivity. Recent studies have reported increase of up to 47% in plant biomass and more than 100% in phosphorus uptake following AMF inoculation (Wu *et al.*, 2024) [4].

The establishment and persistence of AMF in agricultural soils are strongly influenced by fertilizer management practices. In modern farming systems, mycorrhizal inoculants are commonly applied around 20 days after sowing, often overlapping with basal fertilizer application and top-dressing schedules. This raises important questions regarding the compatibility of chemical fertilizers with AMF colonization and survival.

**Corresponding Author:**  
**Suresh Acharya**  
R&D Field, Agrocel Industries  
Pvt. Ltd., Koday, Mandvi,  
Kachchh, Gujarat, India

The present study evaluated the compatibility of MahaBooster Plus, an organic containing Arbuscular Mycorrhizal Fungi (AMF) and Lateral Root Promoting Peptides (LRPP). AMF improve nutrient and water uptake through an extensive external hyphal network, while LRPP stimulate the formation of lateral roots and root hairs, thereby enhancing root architecture and nutrient absorption efficiency. The compatibility of MahaBooster Plus was assessed with commonly used chemical fertilizers, including urea, diammonium phosphate (DAP) and muriate of potash (MOP), as well as with specialized natural formulations such as Mahalaabh Granule (K 23%, Mg 11% and S 15%) and Maha Sulfate (K 12.5%, Mg 5%, S 17.5%, Ca 15%, Zn 0.4-1.0%, B 0.1-0.3%) derived from marine-based sources and Wonder Granule containing 5% each of protein hydrolysate and citric acid. The study evaluated their effects on AMF root colonization, fungal survival, reproductive potential and persistence in soil through spore count analysis.

### Materials and Methods

Field experiments were conducted during the *Rabi* season of 2025-26 at the R&D Farm of AGROCEL Industries Pvt. Ltd. located at Koday to evaluate the symbiotic performance

and persistence of Arbuscular Mycorrhizal Fungi (AMF) under integrated fertilizer management. The experimental site consisted of well-drained sandy loam soil with moderate moisture retention capacity. Wheat (*Triticum aestivum* L.) variety GW-496 was grown in plots measuring 2.40 m × 5.00 m. The experiment was also replicated under pot conditions in a shade-net house.

MahaBooster Plus, containing Arbuscular Mycorrhizal Fungi (AMF) and Lateral Root Promoting Peptides (LRPP), was applied alone and in combination with different fertilizer treatments at 20 days after sowing (DAS). The treatments included conventional chemical fertilizers such as urea, diammonium phosphate (DAP) and muriate of potash (MOP), along with specialty marine-based formulations including Mahalaabh Granules, Maha Sulfate and Wonder Granules. MahaBooster Plus was applied at 4 kg/acre, while NPK was supplied through urea, DAP and MOP at 48, 24, and 16 kg/acre, respectively. Mahalaabh Granules, Maha Sulfate and Wonder Granules were applied at 25, 50, and 5 kg/acre, respectively.

Root colonization was used as the primary indicator to evaluate functional symbiosis and compatibility between AMF and fertilizer treatments. Root colonization percentage was calculated as:

$$\% \text{ Root colonization} = \frac{\text{Number of roots in which mycorrhizal structure seen}}{\text{Total number of roots studied}} \times 100$$

Spore count was included as the other parameter to evaluate fungal survival, reproductive potential and persistence in the soil. Root samples were processed using the clearing and Trypan Blue staining technique (Gerdemann and Nicolson (1963) <sup>[10]</sup> to visualize fungal structures. Spore count analysis was performed using the wet sieving and decanting method (Phillips and Hayman 1970) <sup>[11]</sup> to ascertain fungal survival, reproductive potential and persistence in soil.

Observations were recorded at 40 and 60 DAS, corresponding to critical growth stages associated with high nutrient demand. The 40 DAS observation represented the active tillering and early stem elongation stage, where available soluble phosphorus fertilizers such as DAP may temporarily suppress AMF colonization. The 60 DAS observation corresponded to jointing and flowering initiation stages and was intended to assess the recovery and persistence of fungal colonization as available soil nutrients declined through plant uptake and fixation. Together, root colonization and spore density measurements provided a comprehensive assessment of AMF compatibility, functional symbiosis and long-term persistence in the rhizosphere.

### Results and Discussion

The data on root colonization percentage are presented in Figure 1. The results revealed that the sole application of MahaBooster Plus recorded 100% root colonization at 20 days after application (DAA), corresponding to 40 days after sowing (DAS), thereby establishing the baseline level of colonization. In contrast, root colonization was reduced to 20% in the treatments receiving Urea, DAP and MoP along with MahaBooster Plus; 60% in the treatment receiving Maha Sulfate; and 80% in the treatments receiving Wonder Granules and Mahalaabh Granules. These findings indicate that conventional chemical fertilizers caused a greater initial suppression of AMF root colonization (up to 80% reduction)

compared with specialty fertilizer formulations, which exhibited comparatively lower suppression (20-40%).

As crop growth progressed to 40 DAA (60 DAS), root colonization levels increased substantially in all treatments. The combined application of MahaBooster Plus with chemical fertilizers, root colonization increased to 76% when MahaBooster was applied with DAP to 92% when it was applied with urea and MoP from 20% to 92% at 20 DAA or 40 DAS. This recovery was still more conspicuous to 100% when specialty fertilizers like Maha Sulfate and Wonder Granules were applied with MahaBooster Plus. The recovery of root colonization in Mahalaabh Granules was 84.61%. These observations suggest that the suppressive effect of chemical fertilizers on AMF colonization was transient and diminished with crop advancement, leading to substantial recovery of fungal establishment by 60 DAS. Thus, although chemical fertilizers initially inhibited AMF colonization, the symbiotic association recovered considerably during later growth stages. The application of MahaBooster Plus with specialty fertilizers did not impact the extent of colonization much with 84-100% roots exhibiting colonization.

The comparative effect of root colonization as shown in Figure 1 exhibited a broadly similar trend under pot conditions. Sole application of MahaBooster Plus recorded 80% root colonization, whereas its combined application with chemical fertilizers such as Urea, DAP and MoP resulted in markedly lower colonization levels of 20% each at 20 DAA (40 DAS). In comparison, Maha Sulfate, Wonder Granules and Mahalaabh Granules each recorded 60% root colonization. Relative to field conditions, the suppressive effect of chemical fertilizers on root colonization was comparatively less pronounced under pot conditions, while specialty fertilizers sustained extent of root colonization similar to those observed in the field experiment.

At 40 DAA (60 DAS), root colonization increased considerably irrespective whether the MahaBooster was supplemented with chemical or specialty fertilizers. The highest recovery among chemical fertilizer treatments was observed with DAP (76.92%), followed by Urea (69.23%) and MoP (55.56%). In treatments receiving MahaBooster Plus with specialty fertilizers viz, Maha Sulfate and Wonder Granules recorded 55.56 and 44.44% root colonization, respectively, indicating a slight decline compared to earlier observations. In contrast, Mahalaabh Granules showed a progressive increase in colonization from 60% at 20 DAA to 72% at 40 DAA. Overall, the pot experiment demonstrated that root colonization recovered markedly with crop age in both chemical and specialty fertilizers when they are supplemented with MahaBooster Plus, suggesting gradual establishment and recovery of AMF symbiosis over time. Maha Sulfate and Wonder Granules showed slight dip in root colonization as the crop progressed in age from 40 DAS to 60 DAS.

Spore count is the sounder measure to evaluate fungal survival, reproductive potential and persistence in the soil. The spore count with MahaBooster alone and in combination with both chemical and specialty fertilizers is depicted in Figure 2; while physical appearance of spores extracted from the rhizosphere of each treatment and seen under 20X microscopes is shown in Figure 3. The comparative variation in spore population indicates the differential status of rhizosphere conditions. Spore count data exhibited more or less similar trends of persistent suppression of sporulation from 40 DAS to 60 DAS with combined application of chemical fertilizers and MahaBooster Plus under both field conditions and in pots under shade net house. Contrary to this, numbers of spores increased from 40 DAS to 60 DAS when specialty fertilizers applied with MahaBooster Plus. Mahalaabh granules applied with MahaBooster Plus showed conspicuous improvements in spores under both field and pot conditions. Thus, Mahalaabh Granules was the best specialty fertilizers showing best compatibility with MahaBooster Plus as indicated by both root colonization and spore count.

These findings were further substantiated by the extent of root colonization observed under both field and pot conditions, as illustrated in Figure 4, which compares the performance of MahaBooster Plus applied alone and in combination with chemical and specialty fertilizers at two observation intervals, viz 20 DAA (40 DAS) and 40 DAA (60 DAS). At the earlier growth stage (20 DAA or 40 DAS), root samples exhibited sparse fungal hyphae with limited penetration and spread within the cortical tissues. Arbuscules and vesicles were either poorly developed or present in lower numbers, and the stained root segments showed comparatively lighter colonization, indicating reduced intensity of fungal establishment. In contrast, roots sampled at 40 DAA (60 DAS) displayed a more advanced and well-established mycorrhizal association characterized by dense hyphal networks, extensive cortical colonization and a greater abundance of well-developed vesicles and arbuscular structures.

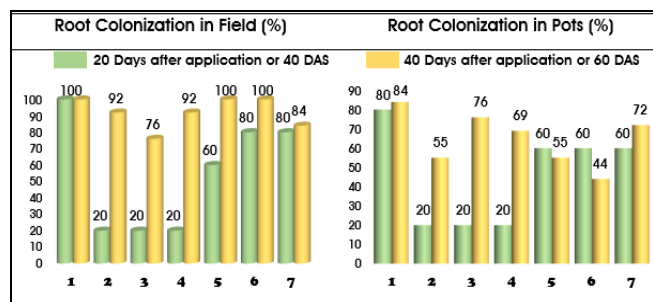
A similar trend was observed under pot conditions, where root segments collected at 40 DAA (60 DAS) appeared more intensely stained and densely colonized than those observed at 20 DAA (40 DAS). Overall, root samples collected at 40 DAA (60 DAS) consistently exhibited greater intensity, density and distribution of mycorrhizal structures compared to those at 20 DAA (40 DAS), indicating progressive establishment and stabilization of the

AMF symbiosis over time. These observations further suggest that the initial suppression of mycorrhizal development caused by chemical fertilizers was largely transient, with substantial recovery in fungal colonization occurring as the crop advanced from 40 to 60 DAS.

The study reflects that chemical fertilizers (Urea, DAP and MoP) exhibited pronounced initial suppression of AMF establishment, reducing root colonization by up to 80% during the early growth stage. Among these treatments, DAP caused the greatest decline in spore population as shown in Figure 2 reducing spore counts from the baseline value of 27 to 16, corresponding to a 40.7% reduction. DAP also recorded the lowest recovery in root colonization at 60 DAS (76%), indicating a comparatively persistent inhibitory effect, likely associated with phosphate-mediated suppression of AMF activity. In contrast, Urea and MoP treatments showed substantial recovery over time, with root colonization increasing to approximately 92% by 60 DAS, suggesting that their suppressive effects were largely transient. These findings agree with the observations of Nahar (2021)<sup>[7]</sup> who has also reported initial suppression of mycorrhizal colonization due to application of P-fertilizers. In consonance to the present findings, Temegne *et al.* (2017)<sup>[9]</sup> also reported that high levels of chemical phosphate fertilizers significantly reduced both the intensity of mycorrhizal colonization and the diversity index of AMF species in the groundnut rhizosphere. In contrast, specialty fertilizers demonstrated superior compatibility with minimal suppression and rapid recovery. Sonbol (2025)<sup>[8]</sup> has also underscored the potential of AMF treatment that improved the antimicrobial efficacy and can be integrated into farming practices to maintain plant growth and crop health against biotic stress.

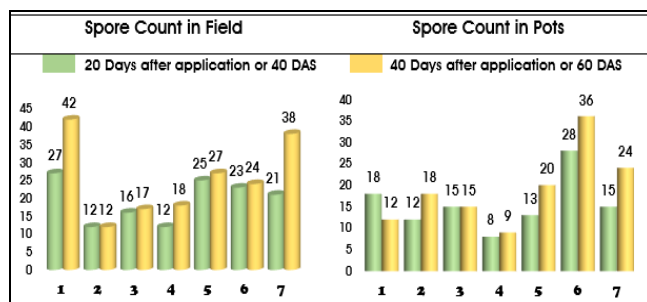
Compared with conventional chemical fertilizers, specialty fertilizers exhibited considerably greater compatibility with AMF colonization. Mahalaabh Granules and Wonder Granules caused only a limited initial reduction of approximately 20% in root colonization, whereas Maha Sulfate showed moderate suppression of about 40%. By 60 DAS, specialty fertilizer treatments achieved full or near-complete recovery of AMF colonization. Among them, Mahalaabh Granules recorded the lowest reduction in spore population, declining only from 42 to 38 spores, equivalent to a 9.5% reduction. This comparatively higher compatibility may be attributed to its organic composition and lower chloride (Cl<sup>-</sup>) content, which likely created a more favorable environment for AMF survival and proliferation.

The agronomic significance of mycorrhizae is likely to increase in the future as agricultural expansion extends into challenging, low-fertility lands. Under such conditions, crop growth is frequently constrained by suboptimal soil physicochemical properties, leading to reduced plant performance and associated carbohydrate sink limitations. These stress conditions closely resemble the environmental contexts under which arbuscular mycorrhizal symbiosis is hypothesized to have evolved, thereby reinforcing its functional relevance in sustaining plant productivity under resource-limited agricultural systems. In this context, the present findings further indicate that MahaBooster Plus can be co-applied with all evaluated fertilizers without permanent loss of AMF efficacy, supporting its suitability for use in low-input and stress-prone agricultural environments where mycorrhizal functioning is particularly critical.



1. MahaBooster Plus (MB); 2. Urea + MB; 3. DAP + MB; 4. MoP + MB; 5. Maha Sulfate + MB; 6. Wonder Granules + MB; 7. Mahalaabh Granules + MB

**Fig 1:** percent root colonization with MahaBooster Plus (MB +) in combination with different fertilizers in field and pots



1. MahaBooster Plus (MB); 2. Urea + MB; 3. DAP + MB; 4. MoP + MB; 5. Maha Sulfate + MB; 6. Wonder Granules + MB; 7. Mahalaabh Granules + MB

**Fig 2:** Spore count with MahaBooster Plus (MB +) in combination with different fertilizers in field and pots

| Treatment               | Spores Field |         | Spores Pot |         |
|-------------------------|--------------|---------|------------|---------|
|                         | 20 days      | 40 days | 20 days    | 40 days |
| MahaBooster Plus (MB)   |              |         |            |         |
| Urea + MB               |              |         |            |         |
| DAP + MB                |              |         |            |         |
| MOP + MB                |              |         |            |         |
| Maha Sulfate + MB       |              |         |            |         |
| Wonder Granules + MB    |              |         |            |         |
| Mahalaabh Granules + MB |              |         |            |         |

**Fig 3:** Spore count at 20 and 40 DAA of MahaBooster Plus with other fertilizers under field conditions and pots in wheat at 20x magnification

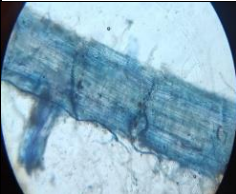
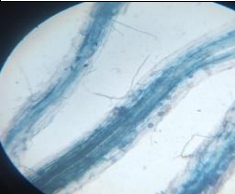
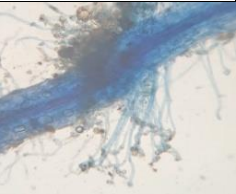
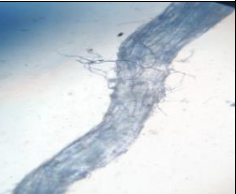
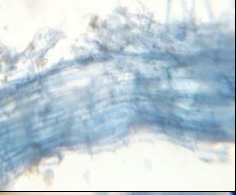
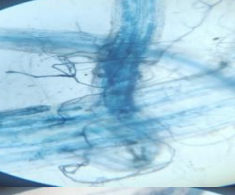
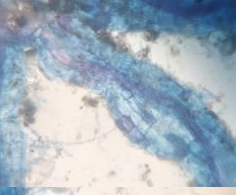
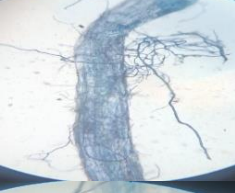
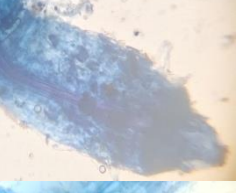
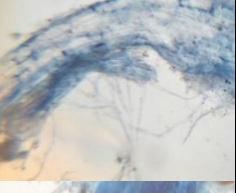
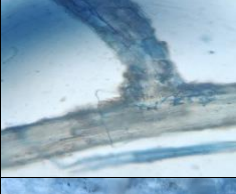
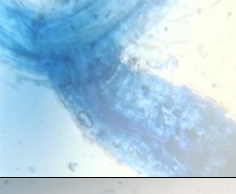
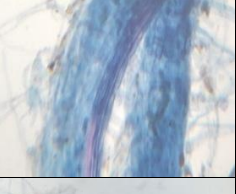
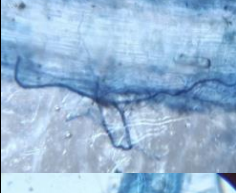
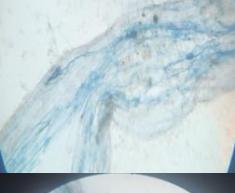
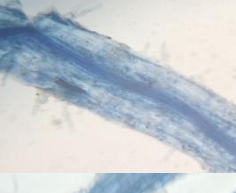
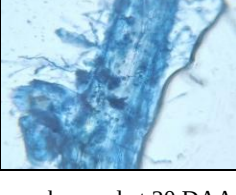
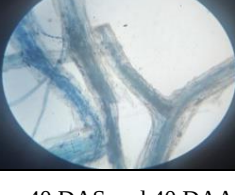
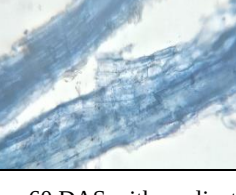
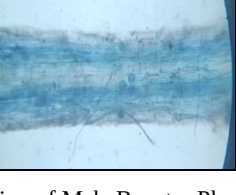
| Treatment               | Root colonization in Field                                                          |                                                                                     | Root colonization in Pots                                                            |                                                                                       |
|-------------------------|-------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
|                         | 20 DAA                                                                              | 40 DAA                                                                              | 20 DAA                                                                               | 40 DAA                                                                                |
| MahaBooster Plus (MB)   |    |    |    |    |
| Urea + MB               |    |    |    |    |
| DAP + MB                |    |    |    |    |
| MOP + MB                |    |    |    |    |
| Maha Sulfate + MB       |   |   |   |   |
| Wonder Granules + MB    |  |  |  |  |
| Mahalaabh Granules + MB |  |  |  |  |

**Fig 4:** Extent of root colonization as observed at 20 DAA or 40 DAS and 40 DAA or 60 DAS with application of MahaBooster Plus at 20 DAS with chemical and specialty fertilizers under field conditions and pots in wheat

**Conclusion**

Thus, it can be concluded from the present study that MahaBooster Plus Initial suppression observed with chemical fertilizers, especially DAP at 40 DAS largely recovers by 60 DAS. Further, Mahalaabh Granules showed the highest compatibility with MahaBooster Plus, showing the lowest AMF suppression (9.5%) and consistent root colonization; owing primarily to its nutrient profile (K, Mg, S along with low Cl<sup>-</sup> contents) that supports AMF biology. Wonder Granules and Maha Sulfate also showed strong compatibility, achieving full colonization recovery. Therefore, the P-containing fertilizers like DAP should be used cautiously by staggered timing or reduced doses as high phosphate suppresses AMF colonization.

**References**

1. Pirozynski KA, Malloch DW. The origin of land plants: a matter of mycotropism. Biosystems. 1975;6:153-164.
2. Koziol L, Schultz PA, House G, Bauer J, Middleton E, Bever JD. Plant microbiome and native plant restoration: The example of native mycorrhizal fungi. BioScience. 2018;68:996-1006.
3. Taylor TN, Remy W, Hass H, Kerp H. Fossil arbuscular mycorrhizae from the Early Devonian. Mycologia. 1995;87(4):560-573.
4. Wu Y, Chen C, Wang G. Inoculation with arbuscular mycorrhizal fungi improves plant biomass and nitrogen and phosphorus nutrients: a meta-analysis. BMC Plant Biol. 2024;24:960.

5. Sun Q, Wang J, Zhang H, Yao L, Si E, Li B, *et al.* The effect of arbuscular mycorrhizal fungi on the growth of wheat seedlings with contrasting phosphorus use efficiencies under low phosphorus stress. *BMC Plant Biol.* 2025;25:1201.
6. Schüßler A, Schwarzott D, Walker C. A new fungal phylum, the *Glomeromycota*: phylogeny and evolution. *Mycol Res.* 2001;105(12):1413-1421.
7. Nahar K, Bovill B, McDonald G. Mycorrhizal colonization in bread wheat varieties differing in their response to phosphorus. *J Plant Nutr.* 2021;44(1):29-45.
8. Sonbol H, Korany SM, nhs M. Exploring the benefits of AMF colonization for improving wheat growth, physiology and metabolism, and antimicrobial activity under biotic stress from aphid infection. *BMC Plant Biol.* 2025;25:198.
9. Temegne NC, Wakem G, Taffouo VD, Mbogne TJ, Onguene AN, Youmbi E, *et al.* Effect of phosphorus fertilization on arbuscular mycorrhizal fungi in the Bambara groundnut rhizosphere. *Afr J Microbiol Res.* 2017;11(37):1399-1410.
10. Gerdemann JW, Nicolson TH. Spores of mycorrhizal *Endogone* species extracted from soil by wet sieving and decanting. *Trans Br Mycol Soc.* 1963;46(2):235-244.
11. Phillips JM, Hayman DS. Improved procedures for clearing roots and staining parasitic and vesicular-arbuscular mycorrhizal fungi for rapid assessment of infection. *Trans Br Mycol Soc.* 1970;55(1):158-161.