ISSN NO: 2769-996X
October 2026

The Effect Of Suspension Application Rates And Timing On The Actual Plant Density Of Winter Wheat

Azimova Madinabonu Gulamjanovna
+998 90 983 05 98
Senior Researcher, Laboratory of Agronomic Practices for Foreign and Local Cotton Varieties, Cotton Breeding, Seed Production and Agrotechnology Research Institute

Abstract

This study examines the effect of suspension application rates and timing on the actual plant density of winter wheat. The rate and timing of suspension application are important factors that may influence seedling establishment, plant survival, and crop stand uniformity. Appropriate application practices can contribute to improving growing conditions and ensuring an optimal plant population. Evaluating the relationship between application parameters and actual plant density helps determine effective agricultural practices for winter wheat cultivation.

Keywords: *winter wheat, suspension, application rate, application timing, actual plant density, seedling establishment, crop stand, agricultural technology, plant population.*

INTRODUCTION

Winter wheat is one of the most important cereal crops worldwide and plays a significant role in food security, agricultural production, and the stability of farming systems. Its productivity depends on several interconnected factors, including seed quality, sowing date, seeding rate, soil moisture, nutrient availability, weather conditions, crop protection practices, and the establishment of an adequate plant population.

Actual plant density is an important indicator of winter wheat establishment. It refers to the number of living plants established per unit area after germination and emergence. It is commonly expressed as plants per square metre (plants/m²). The actual plant density observed in the field may differ from the planned seeding density because not every viable seed germinates, emerges, and survives under field conditions.

Suspension application rates and timing may influence crop establishment depending on the composition of the suspension, its intended purpose, the crop growth stage, soil conditions, and the application method. However, the term suspension must be defined precisely in an agricultural experiment. It may refer to a suspension fertiliser, a plant-protection formulation, a biological preparation, or another liquid agricultural product containing suspended particles. These products differ in composition and mode of action, so their effects on winter wheat cannot be assumed to be identical.

MAIN PART

Actual plant density is one of the principal indicators used to evaluate the success of winter wheat establishment. It reflects the combined effects of seed quality, germination, emergence, early plant development, and plant survival. A field may receive the recommended quantity of seed but still develop an insufficient plant population if soil moisture is inadequate, sowing depth is unsuitable, the seedbed is poorly prepared, or seedlings are damaged by pests and diseases.

The Food and Agriculture Organization of the United Nations (FAO), in its technical material on optimizing plant population and crop establishment, explains that successful wheat establishment requires viable seeds, appropriate placement in the soil, rapid germination, and the emergence of a sufficient number of competitive plants. The publication also emphasizes that soil type, weather, sowing practice, seed quality, and establishment percentage influence the resulting plant population. These principles are relevant when evaluating whether a suspension treatment contributes to improved crop development or merely affects the subsequent growth of plants that have already emerged.

The Agriculture and Horticulture Development Board (AHDB) of the United Kingdom, in its technical guidance “Establishment in wheat: germination and emergence (GS0–GS2),” identifies soil conditions, cultivation practices, weather, seed treatments, sowing rate, and sowing depth as factors influencing wheat

ISSN NO: 2769-996X
October 2026

establishment. Its guidance also notes that high seed rates combined with successful establishment can increase the risk of lodging. This means that the objective of winter wheat cultivation should not simply be to achieve the highest possible plant density, but to establish an appropriate and uniform population suited to the variety and growing conditions.

Suspension application is used in crop management to deliver nutrients or other agricultural preparations in a liquid formulation. In winter wheat production, foliar application of mineral-nutrient suspensions may be used to supplement plant nutrition during particular developmental stages. The effectiveness of such treatment depends on the chemical composition of the preparation, concentration, application volume, weather conditions, crop growth stage, and the physiological condition of the plants.

A directly relevant scientific record is available through FAO AGRIS under the title “Application of Optimal Solution Concentration in Mineral Fertilizer Suspension Foliar Feeding in Winter Wheat.” The record identifies Bakhrom Azimov as the author and gives 2023 as the publication year. It discusses the development of appropriate rates, duration, and application methods for mineral-fertilizer suspensions, with particular attention to autumn wheat grown on irrigated typical grey soils in the Tashkent region of Uzbekistan. The research topic includes plant growth and development, seedling density, grain yield, and grain quality.

An important official regulatory source is Resolution No. PQ-106 of the President of the Republic of Uzbekistan, dated 28 January 2022, entitled On Additional Measures for the Further Development of Seed Production of Agricultural Crops. The resolution addresses the development of agricultural seed production, the use of modern technologies, and the coordination of research and agricultural practice. Its accompanying measures also address crop management and the use of mineral fertilizers and other agricultural inputs.

Although sowing date is not the same as suspension application timing, research on sowing dates provides useful evidence that the timing of agricultural operations can influence winter wheat establishment.

In a study published in 2026, O. Hlushkovskyi examined the effects of sowing rates, sowing dates, and sowing methods on field germination and plant density in winter wheat. The two-year field study compared sowing at soil temperatures of 17–19°C, 14–16°C, and 11–13°C, alongside different seeding rates and sowing methods. The study reported lower field germination in the latest sowing treatment, at 11–13°C, than in the earlier treatments. The results also indicated that late-sown crops had less time to develop sufficient stem density before winter.

Several scientific and institutional sources provide a basis for understanding the relationship between crop management, plant density, and winter wheat development.

First, the 2023 study by Bakhrom Azimov, indexed in FAO AGRIS under the title “Application of Optimal Solution Concentration in Mineral Fertilizer Suspension Foliar Feeding in Winter Wheat,” is directly relevant to the use of mineral-fertilizer suspensions in Uzbek winter wheat production. Its research focus includes the selection of application rates and periods and the evaluation of crop development and seedling density. The source identifies the publication year as 2023 and provides access to the conference paper through E3S Web of Conferences.

Second, a study by T. Kelly Turkington and colleagues, “Winter Wheat Yields Are Increased by Seed Treatment and Fall-Applied Fungicide,” was first published online on 1 July 2016 in Agronomy Journal. The research examined crop management practices affecting winter wheat establishment and yield in the northern Great Plains. The authors discussed the importance of seed treatments and fall-applied fungicides in relation to stand establishment and crop performance. This study is relevant to the broader question of how treatment type and timing affect winter wheat, but it concerns seed treatment and fungicide application rather than mineral-nutrient suspension rates.

Third, the University of Minnesota Extension's technical guidance, “Winter Wheat Seeding Rate and Depth,” explains that seed placement and sowing depth influence emergence and winter survival. It also describes how the desired plant population and expected establishment losses should be considered when calculating the required seeding rate. The guidance gives a general target of approximately 21–23 plants per square foot under the conditions addressed by the publication. This is a region-specific recommendation, not a universal target for Uzbekistan.

A field experiment should be designed to distinguish the effects of application rate from those of application timing. The precise treatment rates should be selected only after the composition of the suspension and its recommended application limits have been established.

ISSN NO: 2769-996X
October 2026

The experiment could include an untreated control and several application-rate treatments, with additional groups representing different application periods. All plots should be managed under comparable conditions, including variety, seed quality, sowing rate, sowing depth, soil preparation, and irrigation.

A randomized block design with multiple replications would help reduce the influence of variation in soil and field conditions. The experiment should record the date of each treatment, the product composition, application rate, application volume, weather conditions, and crop developmental stage.

Actual plant density should be assessed by counting living plants within defined sampling areas. Counts should be conducted at comparable points in each plot and repeated at appropriate developmental stages, such as after emergence and after winter. The same sampling method should be used throughout the experiment.

Plant survival can be calculated using the following formula:

Plant survival (%) = (Number of living plants at the later observation / Number of established plants at the earlier observation) × 100.

For example, if 250 plants/m² are recorded after emergence and 225 plants/m² remain alive at the later assessment, plant survival is 90%. This is an illustrative calculation, not a result from the cited studies.

The collected data should be analysed statistically to determine whether observed differences between treatments are significant. The analysis should consider the separate effects of application rate, timing, and their interaction. If the experimental results show that a particular treatment improves plant survival, this finding can be reported with the observed values, statistical significance, and the conditions under which it occurred.

CONCLUSION

The effect of suspension application rates and timing on the actual plant density of winter wheat is an important subject for agronomic research. Actual plant density reflects the success of crop establishment and subsequent survival, while the application of nutrient suspensions may influence plant development depending on the product's composition, rate, timing, and environmental conditions.

Official Uzbek regulatory material confirms that foliar feeding of cereal crops with nutrient-enriched suspensions is included in the country's agricultural management framework. Scientific literature also demonstrates that plant establishment is affected by seed quality, soil conditions, sowing practices, crop management, and the timing of agricultural operations.

REFERENCES

1. Food and Agriculture Organization of the United Nations (FAO). Optimizing Plant Population, Crop Emergence and Establishment. Technical guidance on wheat establishment and plant population. Official publication.
2. Azimov, B. (2023). Application of Optimal Solution Concentration in Mineral Fertilizer Suspension Foliar Feeding in Winter Wheat. Indexed in FAO AGRIS; published in E3S Web of Conferences, Volume 376, article 02004. FAO AGRIS record.
3. President of the Republic of Uzbekistan. 28 January 2022. Resolution No. PQ-106, On Additional Measures for the Further Development of Seed Production of Agricultural Crops. LexUZ official legal database.
4. Turkington, T. K., Beres, B. L., Kutcher, H. R., et al. (2016). Winter Wheat Yields Are Increased by Seed Treatment and Fall-Applied Fungicide. Agronomy Journal, Volume 108. First published online 1 July 2016. DOI: 10.2134/agronj2015.0573.