



International Journal of Research in Agronomy

E-ISSN: 2618-0618
P-ISSN: 2618-060X
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NAAS Rating (2026): 5.20
www.agronomyjournals.com
2026; 9(6): 1363-1369
Received: 02-05-2026
Accepted: 07-06-2026

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Physiological response of maize (*Zea mays L.*) seedlings to nutrient-enriched seed pelleting under designer seed technology

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DOI: <https://www.doi.org/10.33545/2618060X.2026.v9.i6q.6063>

Abstract

Poor crop establishment and reduced seedling vigour caused by nutrient deficiency and early biotic stresses remain major constraints to maize productivity. Designer seed technology, through nutrient-enriched seed pelleting, offers a promising pre-sowing strategy to enhance early seedling performance by integrating nutrients, crop protection chemicals, herbicides, and beneficial microorganisms into a single seed treatment. The present investigation was conducted during 2019- 2020 at the Seed Technology Research Unit (STRU), National Seed Project, University of Agricultural Sciences, GKVK, Bengaluru, to evaluate the physiological response of maize seedlings to nutrient-enriched seed pelleting. The experiment was laid out in a Randomized Complete Block Design (RCBD) with nine treatments and three replications using the hybrid, Hema. The experimental treatments comprised designer seed pelleting formulations incorporating polymer, metalaxyl, cyantraniliprole+thiamethoxam, diammonium phosphate (DAP), zinc, atrazine, and *Azotobacter chroococcum* in various combinations. Seed quality parameters, including germination, speed of emergence, seedling length, seedling dry weight, seedling vigour indices, and field emergence, were evaluated. Although untreated seeds recorded the highest initial germination (92.0 %) and speed of emergence (64.06), several pelleted treatments significantly enhanced seedling growth and vigour. The treatment comprising polymer + DAP + zinc + atrazine + *Azotobacter chroococcum* (T) produced the greatest mean seedling length (42.18cm), seedling dry weight (76.10mg), seedling vigour index-I (3501), and seedling vigour index-II (6316), while maintaining high field emergence (90.33 %). The initial delay in germination observed in pelleted seeds was attributed to the coating layer, which gradually disappeared as the pellets disintegrated after imbibition. The findings demonstrate that nutrient-enriched seed pelleting under designer seed technology substantially improves seedling vigour and physiological performance by ensuring sustained nutrient availability and enhanced early seedling growth. This technology has considerable potential to improve crop establishment and serve as an effective strategy for enhancing maize productivity under field conditions.

Keywords: Maize, designer seed technology, seed germination, dry weight, seedling vigour, physiological response, field emergence, nutrient enrichment

Introduction

Cereal crops play a crucial role in ensuring global food security and agricultural sustainability by providing a major source of food, feed, and industrial raw materials. Among them, maize (*Zea mays L.*) is one of the world's most important cereal crops because of its high productivity, adaptability, and diverse end uses. In India, it ranks third after rice and wheat in terms of importance and contributes significantly to the country's food security and agricultural economy (FAOSTAT, 2023 and ICAR-IIMR, 2023). Successful crop establishment depends largely on seed quality, which determines germination, seedling vigour, field emergence, and ultimately grain yield. Poor seedling establishment caused by nutrient deficiency, pest attack, diseases, or environmental stress often results in reduced crop productivity (Copeland and McDonald, 2001)^[1]. Designer seed technology is an advanced seed enhancement approach that integrates seed coating or pelleting with nutrients, plant protection chemicals, biofertilizers, and polymers to improve seed performance during the early stages of crop growth. This technology provides multiple benefits by ensuring uniform germination, protecting seedlings from biotic and abiotic stresses, and enhancing physiological efficiency (Halmer, 2008 and Pedrini et al., 2017)^[2].

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Seed pelleting is an important component of designer seed technology in which seeds are enclosed with inert materials along with beneficial additives to produce a uniform spherical shape suitable for precision sowing. Besides improving planting efficiency, pelleted seeds create a favourable micro-environment around the seed, enhancing water availability, nutrient supply, and early seedling development (Roos, 1979; Scott, 1989 and Krishnasamy, 2003)^[3, 4].

The incorporation of nutrients such as diammonium phosphate (DAP) and zinc into seed pellets promotes early root growth, chlorophyll synthesis, enzyme activation, and energy metabolism, thereby improving seedling vigour and physiological performance. Zinc plays an essential role in auxin synthesis, protein metabolism, and photosynthetic activity, while phosphorus supports root establishment and energy transfer (Marschner, 2012 and Alloway, 2008)^[5].

The inclusion of biofertilizers such as *Azotobacter chroococcum* further enhances plant growth by fixing atmospheric nitrogen, producing plant growth-promoting substances, and improving nutrient availability in the rhizosphere. These beneficial microorganisms contribute to increased seedling vigour and better crop establishment under field conditions (Vessey, 2003 and Bhattacharyya and Jha, 2012)^[6].

Similarly, seed-applied fungicides and insecticides provide protection against seed- and soil-borne pathogens and early insect pests, reducing seedling mortality during the critical establishment phase. Polymer coatings improve adhesion and uniform distribution of treatment materials while minimizing dust-off and improving handling characteristics (Taylor et al., 1998 and Avelar, 2012)^[7].

The physiological response of maize seedlings, including germination percentage, speed of emergence, seedling length, dry matter accumulation, chlorophyll content, and vigour indices, serves as an important indicator of seed quality and treatment effectiveness. Improved physiological performance during the initial growth stages generally leads to better field establishment and higher productivity (ISTA, 2023 and Bewley et al., 2012).

Therefore, evaluating the influence of nutrient-enriched seed pelleting under designer seed technology is essential for developing an integrated seed treatment strategy that enhances seed quality, improves physiological responses, and increases the productivity of maize under field conditions.

Materials and Methods

The experiment was carried out during the 2019-2020 at the Seed Technology Research Unit (STRU), National Seed Project (Crops), University of Agricultural Sciences, Gandhi Krishi Vigyan Kendra (GKVK), Bengaluru, Karnataka, India. The experimental field comprised reddish-brown lateritic soil developed under a semi-arid subtropical climate. Before sowing, composite soil samples (0-30 cm depth) were collected and analyzed to determine the initial fertility status and physico-chemical properties. Weather data, including maximum and minimum temperature, rainfall, and relative humidity, were obtained from the meteorological observatory of the University during the crop growth period.

Experimental materials

Certified seeds of the single-cross maize hybrid 'Hema' were obtained from the National Seed Project (Crops), University of Agricultural Sciences, GKVK, Bengaluru. Seeds were dried to a safe moisture content before imposing seed treatments. The

hybrid Hema, developed from the cross NAI-137 × MAI-105, has a maturity duration of 110-120 days and is well adapted to the agro-climatic conditions of southern India.

Experimental design and treatments

The experiment was carried out during Rabi-kharif-2019-20 with twenty seven treatment combinations, laid out in randomized complete block design with three replications.

The details of the experiment are outlined below:

Location: NSP, UAS, GKVK, Bangalore

Crop: Maize

Hybrid: Hema

Season: Rabi-Summer (2019-2020)

Design: Randomized Complete Block Design

Treatments: 9

Replications: 3

Gross plot size: 3.6 m x 3.9 m

Net plot size: 3.5 m x 3.8 m

The treatments consisted of integrated designer seed technologies involving combinations of polymer, fungicide (Metalaxyl), insecticide (Cyantraniliprole + Thiamethoxam), diammonium phosphate (DAP), zinc, atrazine, and *Azotobacter chroococcum*. The treatments were as follows:

- T₁ : Untreated control
- T₂ : Polymer + Metalaxyl + Cyantraniliprole + Thiamethoxam + DAP + Zinc + Atrazine
- T₃ : Polymer + Metalaxyl + Cyantraniliprole + Thiamethoxam + DAP + Zinc + *Azotobacter chroococcum*
- T₄ : Polymer + Metalaxyl + Cyantraniliprole + Thiamethoxam + DAP + Atrazine + *Azotobacter chroococcum*
- T₅ : Polymer + Metalaxyl + Cyantraniliprole + Thiamethoxam + Zinc + Atrazine + *Azotobacter chroococcum*
- T₆ : Polymer + Metalaxyl + DAP + Zinc + Atrazine + *Azotobacter chroococcum*
- T₇ : Polymer + Cyantraniliprole + Thiamethoxam + DAP + Zinc + Atrazine + *Azotobacter chroococcum*
- T₈ : Metalaxyl + Cyantraniliprole + Thiamethoxam + DAP + Zinc + Atrazine + *Azotobacter chroococcum*
- T₉ : Polymer + DAP + Zinc + Atrazine + *Azotobacter chroococcum*

Note: The seed treatment chemicals were applied at the recommended doses of polymer (4 mL kg⁻¹ seed), Metalaxyl (3 g kg⁻¹ seed), Cyantraniliprole + Thiamethoxam (4 mL kg⁻¹ seed), DAP (4 g kg⁻¹ seed), zinc (2 g kg⁻¹ seed), atrazine (10 g kg⁻¹ seed), and *Azotobacter chroococcum* (2 g kg⁻¹ seed).⁻

Seed pelleting procedure

Seed pelleting was carried out using a rotary pan coater at Nongwoo Seed India Pvt. Ltd., Yelahanka, Bengaluru. Initially, seeds were rotated to remove dust particles and lightly moistened with water. Pelleting powder (Easy Pel®) and binder were applied alternately until a uniform coating was formed. Subsequently, fungicide, insecticide, nutrient sources, herbicide, biofertilizer, polymer, binder, and pelleting powder were added sequentially according to the treatment schedule until pellets attained a diameter of approximately 3.5 mm. The coated seeds were finally polished with finishing powder, shade dried, and further dried in a seed dryer before sowing.

Data collection: Initial seed quality of pelleted maize seeds

The initial seed quality of pelleted maize seeds were evaluated under laboratory and field conditions following standard seed testing procedures. The observations recorded included seed germination (%), speed of emergence, mean seedling length (cm), mean seedling dry weight (mg), seedling vigour index-I, seedling vigour index-II and field emergence (%). Seed germination was assessed using the between-paper (BP) method as per the International Seed Testing Association (ISTA, 2010) guidelines. Speed of emergence was calculated according to the method proposed by Maguire (1962)^[8]. Mean seedling length and seedling dry weight were determined from ten randomly selected normal seedlings at the final germination count. Seedling vigour index-I and seedling vigour index-II were computed following the procedure of Abdul-Baki and Anderson (1973)^[9]. Field emergence was recorded on the 14th day after sowing and expressed as the percentage of normal seedlings emerged following the method described by Saha and Basu (1981)^[10].

Statistical analysis

The experimental data were subjected to analysis of variance (ANOVA) appropriate for a Randomized Complete Block Design. Treatment means were compared using the critical difference (CD) test at the 5% probability level wherever the F-

test indicated significant differences (Gomez and Gomez, 1984).

Results and Discussion

Effect of Nutrient-Enriched Seed Pelleting on Initial Seed Quality

Seed Germination (%)

Seed germination varied significantly among the seed pelleting treatments. The untreated control (T₁) recorded the highest germination (92 %), followed closely by T₅ (91 %) and T₄ (90 %), whereas T₂ recorded the lowest germination (80 %) (Table 1. & Plate 1.). Although several pelleting treatments exhibited a slight reduction in germination compared with the control, most treatments-maintained germination above the minimum certification standards for maize seed.

The slight reduction in germination observed in pelleted seeds may be attributed to delayed water imbibition caused by the polymer coating and pelleting materials. The coating initially acts as a physical barrier that slows moisture absorption, thereby delaying radicle protrusion. However, once the coating softens or cracks under adequate soil moisture, normal germination resumes. Similar observations were reported by Taylor and Eckenrode (1993)^[11], who demonstrated that pelleting materials temporarily delay germination without adversely affecting final establishment. Comparable findings were also reported in maize by John *et al.* (2005)^[12] and in rice by Rachana (2019).



Plate 1: Seed germination of pelleted seeds (T₅) Vs. control (T₁)

Speed of Emergence

Significant differences were observed in speed of emergence among treatments. The highest value was recorded in the control (64.06), followed by T₅ (57.28) and T₂ (56.71), while T₄ registered the lowest value (43.78) (Table 1.)

The slower emergence of pelleted seeds can be explained by the delayed hydration associated with polymer-coated seeds. Although emergence was slower during the initial stages, pelleted seeds established normally after sufficient moisture penetration through the coating. The results corroborate earlier reports by Miller and Scott (1967)^[13] and Taylor and Eckenrode (1993)^[11], who observed that pelleted seeds generally exhibit slower initial emergence because of delayed water uptake.

Mean Seedling Length

Mean seedling length differed significantly among treatments. Treatment T₉ recorded the highest seedling length (42.18 cm),

followed by T₈ (41.22 cm), whereas T₄ produced the shortest seedlings (28.38 cm) (Table 2. & Plate 2.). The superiority of T₉ indicates that the combined application of polymer, DAP, zinc, atrazine and *Azotobacter chroococcum* promoted early seedling growth.

Improved seedling growth may be attributed to the immediate availability of essential nutrients supplied through pelleting together with enhanced biological nitrogen fixation by *Azotobacter*. Zinc plays a vital role in auxin synthesis and enzyme activation, while phosphorus supplied through DAP supports vigorous root development and energy metabolism. Similar improvements in seedling growth following polymer and nutrient coating have been reported by Kaushik *et al.* (2014)^[14], Junges *et al.* (2013)^[15] and Sharifi and Khavazi (2011)^[16].



Plate 2: Mean seedling length of pelleted seeds (T₉) Vs. control (T₁)

Mean Seedling Dry Weight

Seedling dry weight was significantly influenced by pelleting treatments. The highest dry weight was recorded in T₉ (76.10 mg), followed by T₈ (70.90 mg) and T₇ (67.10 mg), whereas T₄ recorded the lowest value (44.50 mg) (Table 2.).

The increased dry matter accumulation observed in T₉ indicates better photosynthetic efficiency and efficient mobilization of stored seed reserves during germination. The beneficial effects of polymer coating combined with biofertilizers likely enhanced nutrient uptake, minimized pathogen incidence, and promoted vigorous early growth. Similar findings have been reported by Bakonyi *et al.* (2013)^[17], John *et al.* (2005)^[12] and Junges *et al.* (2013)^[15].

Seedling Vigour Index-I

Seedling vigour index-I showed significant variation among treatments. The highest vigour index was observed in T₉ (3501), which was statistically comparable with T₈ (3462) and T₅ (3410). The lowest value was recorded in T₄ (2555) (Table 3.). The improvement in seedling vigour can be attributed to enhanced nutrient availability and efficient reserve mobilization during germination. Zinc supplied through seed pelleting serves as a cofactor for several metabolic enzymes, enhancing dehydrogenase activity and promoting rapid seedling development. Similar observations were reported by Jeyabal and Kuppaswamy (1999)^[18], Srimathi *et al.* (2002)^[19], and Ananthi *et al.* (2015)^[20].

Seedling Vigour Index-II

Seedling vigour index-II also differed significantly among treatments. Treatment T₉ recorded the highest value (6316),

followed by T₈ (5956) and T₅ (5942), whereas T₂ registered the lowest value (3672) (Table 3.).

Higher vigour index-II reflects superior seedling dry matter accumulation coupled with better germination. The presence of polymer, nutrients, and *Azotobacter* probably enhanced physiological activity, improved nutrient utilization, and reduced early microbial infection, resulting in healthier seedlings. Similar improvements in seed vigour following nutrient-enriched pelleting have been documented by Bony (2017)^[21], Prashanth *et al.* (2018) and Sujatha and Ambika (2018).

Field Emergence

Field emergence ranged from 86.67% to 92.33%. The highest emergence was recorded in the untreated control (92.33%), followed closely by T₅ (91.67%), T₉ (90.33%), and T₈ (89.67%). The lowest field emergence was recorded in T₂ (86.67%) (Fig.1)

Although untreated seeds exhibited slightly faster emergence, treatments incorporating polymer, nutrients, and biofertilizers achieved comparable field establishment while providing superior seedling growth and vigour. The slight delay in emergence is attributed to slower moisture penetration through the coating layer, but this disadvantage was compensated by improved nutrient availability and healthier seedlings after establishment. These findings agree with Taylor and Eckenrode (1993)^[11], Longjiang *et al.* (1997), Sharifi and Khavazi (2011)^[16] and Junges *et al.* (2013)^[15].

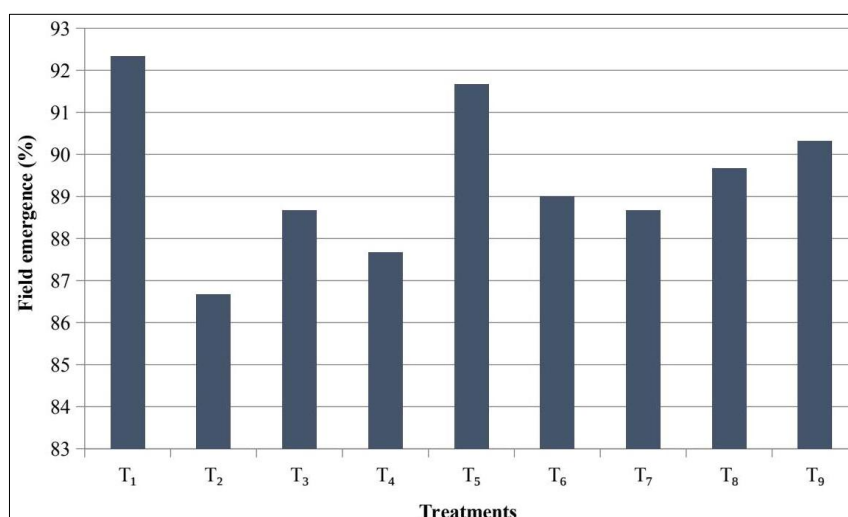


Fig 1: Influence of seed pelleting on field emergence (%) of maize

Treatments

- T : Control
- T₂ : Polymer @ 4.0 ml kg⁻¹ + Metalaxyl @ 3.0 g kg⁻¹ seeds + (Cyantraniliprole+Thiomethoxam) @ 4.0 ml kg⁻¹ seeds + DAP @ 4.0 g kg⁻¹ seeds + Zinc @ 2.0 g kg⁻¹ seeds+ Atrazine @ 10 g kg⁻¹
- T₃: Polymer @ 4.0 ml kg⁻¹ + Metalaxyl @ 3.0gkg⁻¹ seeds + (Cyantraniliprole+Thiomethoxam) @ 4.0 ml kg⁻¹ seeds + DAP @ 4.0 g kg⁻¹ seeds+ Zinc @ 2.0gkg⁻¹ seeds+ *Azotobacter chroococcum* varpi2 : g : kg⁻¹
- T₄ : Polymer @ 4.0 ml kg⁻¹+ Metalaxyl @ 3.0 g kg⁻¹ seeds + (Cyantraniliprole+Thiomethoxam) @ 4.0 ml kg⁻¹ seeds + DAP @ 4.0gkg⁻¹ seeds+ Atrazine @ 10 g kg⁻¹+ *Azotobacter chroococcum* varpi2 : g : kg⁻¹
- T₅ · Polymer @ 4.0 ml kg⁻¹+ Metalaxyl @ 3.0 g kg⁻¹ seeds (Cyantraniliprole+Thiomethoxam) @ 4.0 ml kg⁻¹ seeds + Zinc @ 2.0gkg⁻¹ seeds + Atrazine @ 10 g kg⁻¹+ *Azotobacter chroococcum* varpi & 2 : glog⁻¹
- T₆. Polymer @ 4.0 ml kg⁻¹+ Metalaxyl @ 3.0 g kg⁻¹ seeds + DAP @ 4.0 g kg⁻¹ seeds + Zinc @ 2.0 g kg⁻¹ seeds+ Atrazine @ 10 g kg⁻¹+ *Azotobacter chroococcum* varpi2 : g : kg⁻¹
- T₇ · Polymer @ 4.0 ml kg⁻¹ + (Cyantraniliprole+Thiomethoxam) @ 4.0 ml kg⁻¹ seeds + DAP @ 4.0 g kg⁻¹ seeds+ Zinc textcircleda2.0 : g : kg⁻¹ seeds+ Atrazine @ 10g kg⁻¹+ *Azotobacter chroococcum* varpi2 : g : kg⁻¹
- T₈: Metalaxyl @ 3.0gkg⁻¹ seeds + (Cyantraniliprole+Thiomethoxam) @ 4.0 ml kg⁻¹ seeds + DAP @ 4.0 g kg⁻¹ seeds+ Zinc @ 2.0gkg⁻¹ seeds+ Atrazine @ 10g kg⁻¹ + *Azotobacter chroococcum* @ 2g kg⁻¹
- T₉. Polymer @ 4.0 ml kg⁻¹ + DAP @ 4.0 g kg⁻¹ seeds+ Zinc @ 2.0 g kg⁻¹ seeds + Atrazine @ 10 g kg⁻¹+ *Azotobacter chroococcum* textcircleda2gkg⁻¹

Overall discussion

The present investigation demonstrated that nutrient-enriched seed pelleting substantially improved seedling growth, biomass accumulation, and vigour despite causing a slight reduction in initial germination speed. Treatments containing polymer, DAP, zinc, atrazine, and *Azotobacter chroococcum* were particularly effective in enhancing physiological performance. Among all treatments, T₉ consistently produced the highest seedling length, seedling dry weight, vigour index-I, and vigour index-II, indicating that the synergistic interaction between polymer coating, micronutrients, and beneficial microorganisms significantly improved early seedling establishment.

The enhanced performance may be explained by several physiological mechanisms. Polymer coating provides controlled water uptake and protects the seed from mechanical damage. Zinc functions as an essential micronutrient involved in auxin synthesis, enzyme activation, and chlorophyll formation, while phosphorus supplied through DAP enhances ATP production and root development. In addition, *Azotobacter chroococcum* promotes biological nitrogen fixation, produces plant growth-promoting substances, and improves nutrient availability in the rhizosphere. Together, these factors enhance reserve mobilization, cell division, photosynthetic activity, and biomass accumulation, resulting in vigorous seedlings capable of better field establishment.

Conclusion

Overall, the study confirms that designer seed technology integrating nutrient enrichment with polymer coating and beneficial microorganisms is an effective strategy for improving the physiological quality of maize seedlings and can contribute to better crop establishment under field conditions.

Table 1: Influence of seed pelleting on seed germination (%) and speed of emergence of maize

Treatments	Seed germination (%)	Speed of emergence
T ₁ : Control	92	64.06
T ₂ : Polymer @ 4.0ml kg ⁻¹ +Metalaxyl @ 3.0 g kg ⁻¹ + (Cyantraniliprole+ Thiomethoxam) @ 4.0 ml kg ⁻¹ + DAP @ 4.0 g kg ⁻¹ + Zinc @ 2.0 g kg ⁻¹ + Atrazine @ 10g kg ⁻¹ seeds	80	56.71
T ₃ : Polymer @ 4.0ml kg ⁻¹ +Metalaxyl @ 3.0 g kg ⁻¹ + (Cyantraniliprole + Thiomethoxam) @ 4.0 ml kg ⁻¹ + DAP @ 4.0 g kg ⁻¹ + Zinc @ 2.0 g kg ⁻¹ +Azotobacter chroococcum @ 2g kg ⁻¹ seeds	88	55.27
T ₄ : Polymer @ 4.0ml kg ⁻¹ +Metalaxyl @ 3.0 g kg ⁻¹ + (Cyantraniliprole+ Thiomethoxam) @ 4.0 ml kg ⁻¹ + DAP @ 4.0 g kg ⁻¹ + Atrazine @ 10g kg ⁻¹ +Azotobacter chroococcum @ 2g kg ⁻¹ seeds	90	43.78
T ₅ : Polymer @ 4.0ml kg ⁻¹ +Metalaxyl @ 3.0 g kg ⁻¹ + (Cyantraniliprole + Thiomethoxam) @ 4.0 ml kg ⁻¹ + Zinc @ 2.0 g kg ⁻¹ + Atrazine @ 10g kg ⁻¹ +Azotobacter chroococcum @ 2g kg ⁻¹ seeds	91	57.28
T ₆ : Polymer @ 4.0ml kg ⁻¹ + Metalaxyl @ 3.0 g kg ⁻¹ + DAP @ 4.0 g kg ⁻¹ + Zinc @ 2.0 g kg ⁻¹ + Atrazine @ 10g kg ⁻¹ +Azotobacter chroococcum @ 2g kg ⁻¹ seeds	86	48.97
T ₇ : Polymer @ 4.0ml kg ⁻¹ + (Cyantraniliprole+ Thiomethoxam) @ 4.0 ml kg ⁻¹ + DAP @ 4.0 g kg ⁻¹ + Zinc @ 2.0 g kg ⁻¹ + Atrazine @ 10g kg ⁻¹ +Azotobacter chroococcum @ 2g kg ⁻¹ seeds	87	45.90
T ₈ : Metalaxyl @ 3.0 g kg ⁻¹ + (Cyantraniliprole+ Thiomethoxam) @ 4.0 ml kg ⁻¹ + DAP @ 4.0 g kg ⁻¹ + Zinc @ 2.0 g kg ⁻¹ + Atrazine @ 10g kg ⁻¹ +Azotobacter chroococcum @ 2g kg ⁻¹ seeds	84	51.24
T ₉ : Polymer @ 4.0ml kg ⁻¹ + DAP @ 4.0 g kg ⁻¹ + Zinc @ 2.0 g kg ⁻¹ + Atrazine @ 10g kg ⁻¹ +Azotobacter chroococcum @ 2g kg ⁻¹ seeds	83	51.16
Mean	86.78	52.71
S.Em±	2.60	2.78
CD (P=0.05)	7.54	8.11
CV (%)	4.23	10.54

Table 2: Influence of seed pelleting on mean seedling length (cm) and mean seedling dry weight (mg) of maize

Treatments	Mean seedling length (cm)	Mean seedling dry weight (mg)
T ₁ : Control	35.24	50.60
T ₂ : Polymer @ 4.0ml kg ⁻¹ +Metalaxyl @ 3.0 g kg ⁻¹ + (Cyantraniliprole+ Thiomethoxam) @ 4.0 ml kg ⁻¹ + DAP @ 4.0 g kg ⁻¹ + Zinc @ 2.0 g kg ⁻¹ + Atrazine @ 10g kg ⁻¹ seeds	35.09	45.90
T ₃ : Polymer @ 4.0ml kg ⁻¹ +Metalaxyl @ 3.0 g kg ⁻¹ + (Cyantraniliprole + Thiomethoxam) @ 4.0 ml kg ⁻¹ + DAP @ 4.0 g kg ⁻¹ + Zinc @ 2.0 g kg ⁻¹ + Azotobacter chroococcum @ 2g kg ⁻¹ seeds	33.69	59.50
T ₄ : Polymer @ 4.0ml kg ⁻¹ +Metalaxyl @ 3.0 g kg ⁻¹ + (Cyantraniliprole+ Thiomethoxam) @ 4.0 ml kg ⁻¹ + DAP @ 4.0 g kg ⁻¹ + Atrazine @ 10g kg ⁻¹ + Azotobacter chroococcum @ 2g kg ⁻¹ seeds	28.38	44.50
T ₅ : Polymer @ 4.0ml kg ⁻¹ +Metalaxyl @ 3.0 g kg ⁻¹ + (Cyantraniliprole + Thiomethoxam) @ 4.0 ml kg ⁻¹ + Zinc @ 2.0 g kg ⁻¹ + Atrazine @ 10g kg ⁻¹ + Azotobacter chroococcum @ 2g kg ⁻¹ seeds	37.47	65.30
T ₆ : Polymer @ 4.0ml kg ⁻¹ +Metalaxyl @ 3.0 g kg ⁻¹ + DAP @ 4.0 g kg ⁻¹ + Zinc @ 2.0 g kg ⁻¹ + Atrazine @ 10g kg ⁻¹ + Azotobacter chroococcum @ 2g kg ⁻¹ seeds	36.23	53.90
T ₇ : Polymer @ 4.0ml kg ⁻¹ + (Cyantraniliprole+ Thiomethoxam) @ 4.0 ml kg ⁻¹ + DAP @ 4.0 g kg ⁻¹ + Zinc @ 2.0 g kg ⁻¹ + Atrazine @ 10g kg ⁻¹ + Azotobacter chroococcum @ 2g kg ⁻¹ seeds	36.20	67.10
T ₈ : Metalaxyl @ 3.0 g kg ⁻¹ + (Cyantraniliprole+ Thiomethoxam) @ 4.0 ml kg ⁻¹ + DAP @ 4.0 g kg ⁻¹ + Zinc @ 2.0 g kg ⁻¹ + Atrazine @ 10g kg ⁻¹ + Azotobacter chroococcum @ 2g kg ⁻¹ seeds	41.22	70.90
T ₉ : Polymer @ 4.0ml kg ⁻¹ + DAP @ 4.0 g kg ⁻¹ + Zinc @ 2.0 g kg ⁻¹ + Atrazine @ 10g kg ⁻¹ + Azotobacter chroococcum @ 2g kg ⁻¹ seeds	42.18	76.10
Mean	36.19	59.31
S.Em±	0.27	0.45
CD (P=0.05)	1.02	1.70
CV (%)	1.41	3.44

Table 3: Influence of seed pelleting on seedling vigour index I and seedling vigour index II of maize

Treatments	SVI-I	SVI-II
T ₁ : Control	3243	4655
T ₂ : Polymer @ 4.0ml kg ⁻¹ +Metalaxyl @ 3.0 g kg ⁻¹ + (Cyantraniliprole+ Thiomethoxam) @ 4.0 ml kg ⁻¹ + DAP @ 4.0 g kg ⁻¹ + Zinc @ 2.0 g kg ⁻¹ + Atrazine @ 10g kg ⁻¹ seeds	2808	3672
T ₃ : Polymer @ 4.0ml kg ⁻¹ +Metalaxyl @ 3.0 g kg ⁻¹ + (Cyantraniliprole + Thiomethoxam) @ 4.0 ml kg ⁻¹ + DAP @ 4.0 g kg ⁻¹ + Zinc @ 2.0 g kg ⁻¹ + Azotobacter chroococcum @ 2g kg ⁻¹ seeds	2965	5236
T ₄ : Polymer @ 4.0ml kg ⁻¹ +Metalaxyl @ 3.0 g kg ⁻¹ + (Cyantraniliprole+ Thiomethoxam) @ 4.0 ml kg ⁻¹ + DAP @ 4.0 g kg ⁻¹ + Atrazine @ 10g kg ⁻¹ + Azotobacter chroococcum @ 2g kg ⁻¹ seeds	2555	4005
T ₅ : Polymer @ 4.0ml kg ⁻¹ +Metalaxyl @ 3.0 g kg ⁻¹ + (Cyantraniliprole + Thiomethoxam) @ 4.0 ml kg ⁻¹ + Zinc @ 2.0 g kg ⁻¹ + Atrazine @ 10g kg ⁻¹ + Azotobacter chroococcum @ 2g kg ⁻¹ seeds	3410	5942
T ₆ : Polymer @ 4.0ml kg ⁻¹ + Metalaxyl @ 3.0 g kg ⁻¹ + DAP @ 4.0 g kg ⁻¹ + Zinc @ 2.0 g kg ⁻¹ + Atrazine @ 10g kg ⁻¹ + Azotobacter chroococcum @ 2g kg ⁻¹ seeds	3094	4635
T ₇ : Polymer @ 4.0ml kg ⁻¹ + (Cyantraniliprole+ Thiomethoxam) @ 4.0 ml kg ⁻¹ + DAP @ 4.0 g kg ⁻¹ + Zinc @ 2.0 g kg ⁻¹ + Atrazine @ 10g kg ⁻¹ + Azotobacter chroococcum @ 2g kg ⁻¹ seeds	3147	5838
T ₈ : Metalaxyl @ 3.0 g kg ⁻¹ + (Cyantraniliprole+ Thiomethoxam) @ 4.0 ml kg ⁻¹ + DAP @ 4.0 g kg ⁻¹ + Zinc @ 2.0 g kg ⁻¹ + Atrazine @ 10g kg ⁻¹ + Azotobacter chroococcum @ 2g kg ⁻¹ seeds	3462	5956
T ₉ : Polymer @ 4.0ml kg ⁻¹ + DAP @ 4.0 g kg ⁻¹ + Zinc @ 2.0 g kg ⁻¹ + Atrazine @ 10g kg ⁻¹ + Azotobacter chroococcum @ 2g kg ⁻¹ seeds	3501	6316
Mean	3131	5139
S.Em±	20.90	2.90
CD (P=0.05)	62.3	11.80
CV (%)	1.20	1.86

References

- Copeland, L. O., & McDonald, M. B. (2001). Principles of Seed Science and Technology. Springer.
- Halmer, P. (2008). Seed technology and seed enhancement. *Acta Horticulturae*, 771, 17-26.
- Roos, E. E. (1979). Storage Behavior of Pelleted, Tableted, and Taped Lettuce Seed1. *Journal of the American Society for Horticultural Science*, 104(2), 283-288.
- Scott, J. M. (1989). Seed coatings and treatments and their effects on plant establishment. *Advances in agronomy*, 42, 43-83.
- Marschner, P. (2012). *Marschner's Mineral Nutrition of Higher Plants*. Academic Press.
- Vessey, J. K. (2003). Plant growth-promoting rhizobacteria as biofertilizers. *Plant and Soil*, 255, 571-586.
- Taylor, A. G., Allen, P. S., Bennett, M. A., Bradford, K. J., Burris, J. S., & Misra, M. K. (1998). Seed enhancements. *Seed Science Research*, 8, 245-256.
- Maguire, J. D. (1962). Speed of germination-aid in selection and evaluation for seedling emergence and vigor.
- Abdul Baki, A. A., & Anderson, J. D. (1973). Vigor determination in soybean seed by multiplecriteria 1. *Crop science*, 13(6), 630-633.
- Saha, R., & Basu, R. N. (1981). Maintenance of soybean seed viability by hydrationdehydration treatments.
- Taylor, A. G., & Eckenrode, C. J. (1993). Seed coating technologies to improve establishment and crop performance. *HortTechnology*, 3, 151-156.
- John, S. S., Bharathi, A., Natesan, P., & Raja, K. (2005). Effect of polymer coating on germination and seedling vigour in maize cv. Co 1. *Karnataka J. Agric. Sci.*, 18(2), 343-348.

13. Miller, W. F., & Scott, J. M. (1967). Effect of seed pelleting on emergence of tomato. Proceedings of the Association of Official Seed Analysts, 57, 178-183.
14. Kaushik, S. K., Rai, A. K., & Singh, V. (2014). Seed quality of maize with polymer film coating in storage. International Journal of Innovative Research in Science, Engineering and Technology, 3, 14353-14358.
15. Junges, E., Toebe, M., Santos, R. F. D., Finger, G., & Muniz, M. F. B. (2013). Effect of priming and seed-coating when associated with *Bacillus subtilis* in maize seeds. Revista Ciência Agronômica, 44(3), 520-526.
16. Sharifi, R. S., & Khavazi, K. (2011). Effects of seed inoculation with *Azotobacter* and *Azospirillum* on maize yield and growth. World Applied Sciences Journal, 12, 215-220.
17. Bakonyi, N., Bott, S., Gajdos, E., Szabó, A., Jakab, A., Tóth, B., & Veres, S. (2013). Using biofertilizer to improve seed germination and early development of maize. Pol. J. Environ. Stud, 22(6), 1595-1599.
18. Jeyabal, A., & Kuppaswamy, G. (1999). Seed pelleting with nutrients and biofertilizers for improving seed quality and productivity. Madras Agricultural Journal, 86, 198-201.
19. Srimathi P, Malarkodi K, Natarajan K. Selection of seeds for elite seedling production in Jamun (*Syzygium cumini* Skeels). Journal of Non-Timber Forest Products. 2002;9(3/4):163-164.<https://doi.org/10.54207/bsmps2000-2002-59gwo9>
20. Ananthi, M., Selvaraju, P., & Srimathi, P. (2015). Effect of seed treatment on seed and seedling quality characters in Redgram cv. Co (Rg) 7. International Journal of Science and Nature, 6(2), 205-208.
21. Bony, B. P., (2017). Effect of polymer coating integrated with fungicide, insecticide and bioagent on soybean seed quality and yield. Legume Research, 40, 731-736.
22. Ahmad, F., Ahmad, I., & Khan, M. S. (2008). Screening of free-living rhizospheric bacteria for their multiple plant growth promoting activities. Microbiological research, 163(2), 173-181.
23. Alloway, B. J. (2008). Zinc in soils and crop nutrition.
24. Avelar, S. A. G. (2012). Seed coating in agricultural crops. Journal of Seed Science, 34, 186- 196.
25. Bewley, J. D., Bradford, K., & Hilhorst, H. (2012). Seeds: physiology of development, germination and dormancy. Springer Science & Business Media.
26. Bhattacharyya, P. N., & Jha, D. K. (2012). Plant growth-promoting rhizobacteria: emergence in agriculture. World Journal of Microbiology and Biotechnology, 28, 1327-1350.
27. FAOSTAT. (2023). Food and Agriculture Organization of the United Nations.
28. International Rules for Seed Testing (ISTA). (2010). Seed Sci. Technol., 24: 307-335.
29. ICAR-Indian Institute of Maize Research (IIMR). (2023). Annual Report.
30. ISTA. (2023). International Rules for Seed Testing. International Seed Testing Association.
31. Krishnasamy, V. (2003). Seed pelleting principles and practices, ICAR short course on seed hardening and pelleting technologies for rainfed/garden land ecosystems, May 27 to June 5. Univ., Coimbatore, India, 96.
32. Pedrini, S., Merritt, D. J., Stevens, J., & Dixon, K. W. (2017). Seed coating technologies for ecological restoration. Restoration Ecology, 25, 106-111.