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Arachis hypogaea Farm Fertilization Using Huddle Hierarchy with Robustness against Nutrient Deficiency

Varalakshmi R*

Department of Computer Applications (MCA), School of Computing Sciences, VELS University, Chennai, Tamil Nadu, India

***Corresponding author:** Varalakshmi R, Department of Computer Applications (MCA), School of Computing Sciences, VELS University, Chennai, Tamil Nadu, India, Tel: 04422662500; E-mail: rvara.scs@velsuniv.ac.in

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Abstract

In the proposed huddle hierarchy scheme based fertilization, farm land of *Arachis hypogaea* are grouped as huddle and they are assigned with unique IDs based on hierarchical representation. This scheme uses the existing extended Euclidean algorithm for finding the greatest common divisor (GCD) of two positive integers using their prime powers. In order to provide a restricted group based irrigation and fertilization. There is a group controller in charge of irrigation and fertilization management. The group may share excess or surplus water and fertilization among themselves or with the group controller. The focus deals with the reduction of complexity during the watering and fertilizing process by reducing the number of multiplication operations by using the fast fourier transform (FFT) algorithm. In order to measure the robustness of the scheme against yellowing of older leaves due to nitrogen deficiency and inter-venial chlorosis of young and newly emerging leaves, mathematical analysis has been derived.

Keywords: Arachis hypogaea; Fertilization; Water irrigation

Introduction

Fertilization

Nitrogen (N): *Arachis hypogaea* obtains its nitrogen (N) supplies through a symbiotic process with bacteria (*Bradyrhizobium* spp.). Most soils have nitrogen fixing bacteria in it. It may be helpful to inoculate seeds with rhizobia to guarantee nitrogen fixing. In India, a starter dose of 10 N/ha kg to 15 N/ha kg is suggested until the symbiotic nitrogen fixation is starting. Researchers have depicted that elevated doses of nitrogen application hinder biological fixation. In case nitrogen deficiency symptoms such as yellowing of older leaves are seen a top dressing with nitrogen is require red [1]. Phosphorus (P) is a vital nutrient for *Arachis hypogaea*. Its deficiency typically arises in soils with low organic matter. This deficiency can be overcome by applying P fertilizer at the time of planting [2].

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In this research work, an attempt is made to improve the methods for fertilization of *Arachis hypogaea* farms with safe and efficient group distribution schemes. In this work, the proposed Huddle Hierarchy based resource management scheme (HHRM) is used for identifying and distributing fertilizers where fast fourier transform (FFT), a divide and conquer approach is used to reduce the computational complexity.

FIG. 1. **Typical *Arachis hypogaea* farm.**

Water irrigation management

To prevail over the physical limitations of the customary irrigation system with the development of a sprinkler node that will sense the restricted soil moisture and communicate wireless technology, and activate its sprinkler based on a centrally computed agenda [1]. A model is then developed to compute moisture movement from runoff, absorption, and diffusion. Integrated with an optimization framework, optimal valve scheduling can be found for each node in the space. Agenda for irrigation at 0.40 and 0.60 IW/CPE ratio during vegetative and reproductive phases respectively. Control irrigation on the basis of physiological growth phases. And Pegging, flowering and pod development phases are critical for irrigation during which period adequate soil moisture is essential [3-5] (FIG. 1).

Control irrigation as per the following growth phase of the crop.

Pre-flowering phase: 1 to 25 days

Flowering phase: 26 to 60 days

Maturity phase: 61 to 105 days

Concern irrigation as follows pre-sowing, Life irrigation, 4-5 days after sowing 20 days after sowing, at flowering give two irrigations, at pegging stage give one or two irrigations and in pod development stage, 2-3 irrigations depending on the soil type.

Mathematical analysis

The yellowing of older leaves is nitrogen deficiency symptom in *Arachis hypogaea*. In this section, the proper fertilization of nitrogen and phosphorus by proposed scheme is analyzed mathematically and its robustness against yellowing of older leaves and inter-venial chlorosis of young has been discussed. In the proposed scheme, with the key terms k_g, k_i and $k_{\varepsilon i}$, the Group Controller (GC) computes the pairs) in the following manner:

$$X_i = K_g / (k_i \oplus k_{\varepsilon i}), Y_i = K_g \bmod (k_i \oplus k_{\varepsilon i})$$

GC then publishes (X_i,Y_i). From this public information, each group member M_i can be able to retrieve the N and P by computing

$k_g = X_i *(K_1 \oplus K_{\varepsilon 1}) + Y_i$

Only members can be able to retrieve the resources using pairs (X_i,Y_i). Given k_g, k_i and $k_{\varepsilon i}$, it is easy to compute

$$X_i = K_g / (\mathrm{k_i} \oplus \mathrm{k}_{\varepsilon i}), Y_i = K_g \bmod (\mathrm{k_i} \oplus \mathrm{k}_{\varepsilon i})$$

Given (X_i,Y_i) it is difficult to compute k_g, in polynomial time, without knowing k_i and $k_{\varepsilon i}$, such that $k_g = X_i *(K_1 \oplus K_{\varepsilon 1}) + Y_i$ and it is NP hard. For large size k_g even if several pairs (X_i,Y_i) are known, it is very difficult to compute k_g, unless the corresponding k_i's and $k_{\varepsilon i}$'s are known.

Suppose,

$$K_g = X_i \times (\mathrm{k_i} \oplus \mathrm{k}_{\varepsilon i}) + Y_1 \left(K_1 \,\&\, K_{\mathrm{k}_{\varepsilon i}} \textit{ are unknown}\right) \tag{1}$$

$$K_g = X_2 \times (\mathrm{k_2} \oplus \mathrm{k}_{\varepsilon 2}) + Y_2 \left(K_2 \,\&\, K_{\mathrm{k}_{\varepsilon 2}} \textit{ are unknown}\right) \tag{2}$$

$$K_g = X_3 \times (\mathrm{k_3} \oplus \mathrm{k}_{\varepsilon 3}) + Y_3 \left(K_3 \,\&\, K_{\mathrm{k}_{\varepsilon 3}} \textit{ are unknown}\right) \tag{3}$$

From the first two equations,

$$X_i \times (\mathrm{k_i} \oplus \mathrm{k}_{\varepsilon i}) + Y_1 = X_2 \times (\mathrm{k_2} \oplus \mathrm{k}_{\varepsilon 2}) + Y_2$$

$$X_i \times (\mathrm{k_i} \oplus \mathrm{k}_{\varepsilon i}) - X_2 \times (\mathrm{k_2} \oplus \mathrm{k}_{\varepsilon 2}) = \mathrm{Y_2} - \mathrm{Y_1} \text{ say } (\mathrm{Y_2} > \mathrm{Y_1})$$

$$X_i \times (\mathrm{k_i} \oplus \mathrm{k}_{\varepsilon i}) - X_2 \times \left[(\mathrm{k_2} \oplus \mathrm{k}_{\varepsilon 2}) + R_1\right] = C_1$$

Where $C_1=Y_2-Y_1$ and $(K_2 \oplus K_{\varepsilon 2}) = [(K_1 \oplus K_{\varepsilon 1})] + R_1$

$$(X_2-X_1)\,(K_1 \oplus K_{\varepsilon 1}) - X_2R_1 = C_1 \tag{4}$$

Similarly, from Equation (1) and (3),

$$(X_1-X_3)\,(K_1 \oplus K_{\varepsilon 1}) - X_3R_2 = C_2 \tag{5}$$

from Equation (2) and (3),

$(X_2\text{-}X_3)\ (K_2 \oplus K_{\varepsilon 2}) - X_3R_3 = C_3$

$(X_2\text{-}X_3)\ [(K_1 \oplus K_{\varepsilon 1}) + R_1] - X_3R_3 = C_3$

$$(X_2\text{-}X_3)\ [(K_1 \oplus K_{\varepsilon 1}) + (X_2\text{-}X_3)\ R_1 - X_3R_3 = C_3 \qquad (6)$$

Thus, with equations (4-6) the unknowns $R_{1,}$ $R_{2,}$ $R_{3,}$ K_1 and $K_{\varepsilon 1}$ are determined. Therefore, one of these values will be left arbitrary; hence the value of k_g cannot be determined easily and correctly. The strength of the proposed algorithm relies on the fact that with the product of two large prime numbers, it is highly difficult to find the two factors in polynomial time i.e., it is NP-hard [6-9]. Thus, the field ground k_g is more secure and safe preventing it from fertilization robustness and irrigation robustness.

Simulation result and analysis

Using this method, the fertilization and irrigations are achieved. The failure of the farm due to this case are evaluated and the charted below.

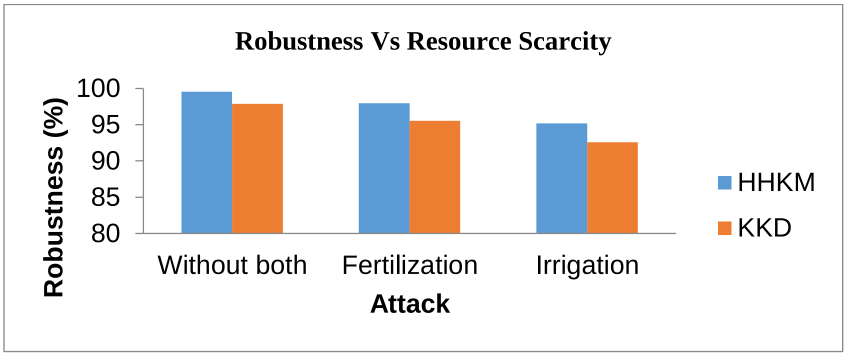

FIG. 2. **Robustness against resource scarcity.**

From the above FIG. 2 it is observed that among the five scenarios conducted without any resource scarcity, the proposed scheme has the robustness of 99.55% whereas most available provides robustness of 97.87%.

Since security is a major concern in implementing the multicast security, the proposed algorithm uses the extended Euclidean algorithm for finding the greatest common divisor (GCD) of two positive integers using their prime powers [10-14]. It uses Prime factorization which requires splitting an integer into factors that are prime numbers. It is known that every integer has a unique prime factorization. Multiplying two prime integers together is easy, but factoring the product is much more difficult. This method will suit in an environment where users are constantly joining and/or leaving the system with low communication overcomes and gets forward and backward secrecy [15]. Thus, the proposed Huddle Hierarchy based resource Management scheme by using extended Euclidean algorithm that is based on the complexity in factorizing the large prime numbers resists the resource scarcity vectors like fertilizer and irrigation and leads to robustness of 97.95% and 95.16% respectively [16-19].

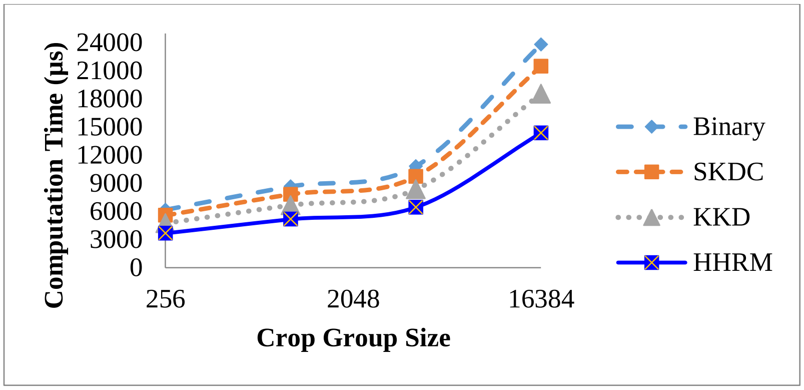

FIG. 3. **GC key computation time for various resource distribution.**

It is evident from the values that the computation time of proposed algorithm is found to be better both in the server area and the client area than the other algorithms. The storage complexity is (cn*c)+tc+1 and the Communication complexity is found to be (n-1) [(3 × p)-1] + 2p (FIG. 3).

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