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Impact of humic acid and NAA on seed germination in Mung bean (*Vigna radiata* L.)

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Abstract

The present investigation was conducted at the Department of Botany and Research Centre, Padmashri Vikhe Patil College of Art, Science & Commerce, Pravaranagar, Tal-Rahata, Dist. Ahmednagar, during the Kharif season of 2023. The experimental design utilized was a Completely Randomized Design (CRD), which included nine distinct treatments with four replications each. Seeds of the Mung bean variety Vaibhav were sourced from M.P.K.V., Rahuri. A germination assay was performed employing 100 seeds per treatment, utilizing the roll towel paper method under controlled environmental conditions of $25 \pm 2^\circ\text{C}$ temperature and $95 \pm 2\%$ relative humidity within a designated germination chamber. The seeds were subjected to soaking in various concentrations of humic acid (50 ppm, 100 ppm, 150 ppm, 200 ppm) and Naphthalene Acetic Acid (NAA) (15 ppm, 25 ppm, 35 ppm, 45 ppm) for a duration of four hours. Assessments were conducted on the eighth day to measure germination percentage, seedling vigor, root and shoot lengths, and the root to shoot ratio. The results demonstrated that seeds immersed in humic acid at a concentration of 150 ppm (T4) exhibited a significantly elevated germination percentage of 90.25% and a seedling vigor index of 2908.93, relative to the untreated control group. Moreover, the application of NAA at 45 ppm (T9) resulted in a significantly enhanced root to shoot ratio of 0.84. Additionally, the treatment involving humic acid at 100 ppm (T3) effectively augmented both root and shoot lengths.

Keywords: Seed germination, mung bean, seed soaking, NAA, PGR and Humic acid

Introduction

Mung bean (*Vigna radiata* (L.)), commonly referred to as green gram, is recognized in the literature as a vital self-pollinated and short-duration pulse crop, ranking third in significance after chickpea and pigeon pea (Markham *et al.*, 2018) [6]. The Central Asian region is acknowledged as the primary centre of genetic diversity for this species (Kumar and Kumar, 2014) [12].

In India, the cultivation of Mung bean is concentrated in states such as Maharashtra, Rajasthan, Bihar, Andhra Pradesh, Gujarat, Odisha, Madhya Pradesh, Punjab, and Uttar Pradesh, where it occupies approximately 16% of the total area dedicated to pulses, constituting the third most important pulse crop within the nation. Unique among pulse crops, *Vigna radiata* can be cultivated year-round across various cropping seasons, with growth behaviour influenced by seasonal factors including photoperiod, temperature, and humidity. The seeds contain approximately 25% protein, a value significantly higher (nearly threefold) than that found in conventional cereal crops. As a group, pulses serve as critical dietary sources of protein, energy, minerals, and vitamins essential for human nutrition. In India, Mung bean is cultivated across 3.701 million hectares, yielding a total production of 1.761 million tonnes, resulting in a productivity of 476 kg/ha. In Maharashtra specifically, the area under Mung bean cultivation encompasses 389,000 hectares, producing 183,000 tonnes, with a productivity rate of 470 kg/ha (Source: DES, GoI Avg. of 2018-19 to 2022-23) [8].

Materials and Methods

The experiment was carried in a controlled laboratory setting using germination paper. A series of plant growth regulator (PGR) treatments were developed, which included a control treatment (T1) with water, in addition to varying concentrations of humic acid at 50 ppm

(T2), 100 ppm (T3), 150 ppm (T4), and 200 ppm (T5). Additionally, Naphthalene acetic acid (NAA) was tested at concentrations of 15 ppm (T6), 25 ppm (T7), 35 ppm (T8), and 45 ppm (T9). Seeds of the Mung bean variety Vaibhav were soaked in these PGR solutions for four hours^[5]. Each treatment involved 100 seeds, with four replicates, following the roll towel paper method as outlined by the International Seed Testing Association (ISTA, 2010)^[3].

The experimental conditions were carefully controlled, maintaining a temperature of 25 ± 2 °C and a relative humidity of $95 \pm 2\%$ within the germination chamber. Germination was monitored at 24-hour intervals over a period of 8 days, with seeds considered germinated when the radical measured at least 2 mm in length. The germination percentage was calculated using the formula: Germination Percentage = (Number of germinated seeds / Total seeds subjected to germination) $\times$ 100. On the eighth day, seedlings from each replicate were randomly selected for measurement. The shoot length was measured from the collar region to the tip of the longest leaf, while the root length was recorded from the base of the stem to the tip of the longest root, both in centimetres. Seedling vigor was calculated using the formula by Abdul-Baki and Anderson (1973)^[1]: Vigor Index = (Shoot length + Root length) $\times$ Germination Percentage. The root-to-shoot ratio (RSR) was determined by dividing the total root length by the total shoot length.

Results and Discussion

The investigation into seed characteristics in this study revealed statistically significant differences resulting from the various seed soaking treatments implemented. The primary metrics assessed comprised germination rate, root length (in cm), shoot length (in cm), root to shoot ratio, and seedling vigor. These findings collectively highlight the significant influence of the treatment methods on seed performance indicators, consistent with earlier studies on pulse crops.

In the current study, seeds subjected to treatment with humic acid at a concentration of 150 ppm demonstrated a

germination rate of 90.25%. This finding aligns with the results of Kumar *et al.* (2021)^[12], which indicated that humic acid markedly improves germination rates in chickpeas. These findings suggest that organic amendments like humic acid could be integral for improving seed germination, potentially due to enhanced nutrient availability and rooting conditions.

Conversely, naphthalene acetic acid (NAA) at 45 ppm resulted in a lower germination percentage of 52.50%. This outcome is corroborated by Singh and Malhotra (2020)^[10], who indicated that synthetic auxin treatments can adversely affect germination rates in beans. The reduced impact of NAA highlights the necessity for caution when utilizing synthetic growth regulators, as evidenced by the stark contrast in the effectiveness of the organic versus synthetic treatments in promoting seed germination.

The analysis further revealed significant differences in seedling vigor, with humic acid treatments yielding the highest vigor score of 2908.93, while NAA treatment resulted in a dramatically reduced vigor score of 566.95. This pattern aligns with the observations made by Patel *et al.* (2022)^[7], who noted that organic amendments lead to enhanced vigor in lentils over their synthetic counterparts. The pronounced decline in vigor associated with NAA treatment reinforces the notion that the type and concentration of growth treatments warrant careful consideration, especially in light of their potential detrimental effects.

Interestingly, the root to shoot ratio was maximized in the NAA treatment at 45 ppm, recorded at 0.84. This finding corresponds with the work of Alvi *et al.* (2023)^[2], who demonstrated that specific growth regulators can enhance root to shoot ratios in pulse crops. However, the results of our study suggest that while NAA may optimize this ratio, it does not translate into improved overall seedling vigor. Additionally, trends in root length improvements associated with humic acid applications echo the findings of Jadhav and Dahanukar (2019)^[4], further supporting the efficacy of organic treatments in enhancing root elongation.

Table 1: Impact of Humic acid and NAA on germination percentage and Seedling vigor (SV-I)

Treatments (Humic acid and NAA ppm)	Germination percentage	Seedling vigor (SV-I)
Control (T ₁)	79.75	1983.78
50 ppm HA (T ₂)	85.50	2905.54
100 ppm HA (T ₃)	82.25	2908.83
150 ppm HA (T ₄)	90.25	2908.93
200 ppm NAA (T ₅)	83.50	2871.13
15 ppm NAA (T ₆)	67.25	1041.25
25 ppm NAA (T ₇)	73.50	940.69
35 ppm NAA (T ₈)	60.75	644.86
45 ppm NAA (T ₉)	52.50	566.95
SE(m)±	3.201	90.02
CD at 5%	9.343	262.75

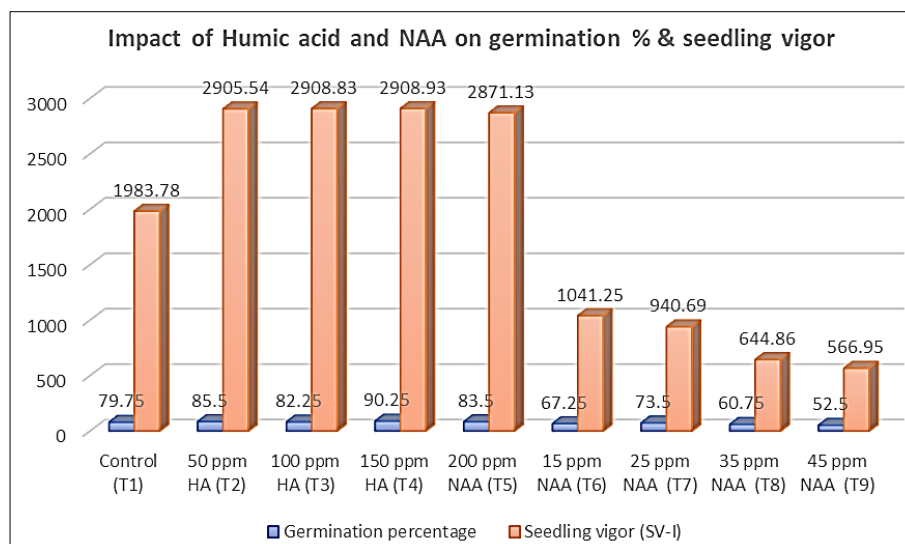


Fig 1: Impact of Humic acid and NAA on germination percentage and Seedling vigor (SV-I)

Table 2: Impact of Humic acid and NAA on Shoot length (cm), Root length(cm) and root to shoot ratio.

Treatments (Humic acid and NAA ppm)	Shoot length(cm)	Root length(cm)	Root to shoot ratio
Control (T ₁)	17.93	6.88	0.39
50 ppm HA (T ₂)	23.75	10.24	0.43
100 ppm HA (T ₃)	25.30	10.30	0.41
150 ppm HA (T ₄)	22.73	9.69	0.43
200 ppm NAA (T ₅)	24.35	9.80	0.40
15 ppm NAA (T ₆)	10.55	5.17	0.50
25 ppm NAA (T ₇)	8.05	4.59	0.57
35 ppm NAA (T ₈)	6.50	4.36	0.67
45 ppm NAA (T ₉)	6.04	4.95	0.84
SE(m)±	0.652	0.220	0.044
CD at 5%	1.905	0.642	0.129

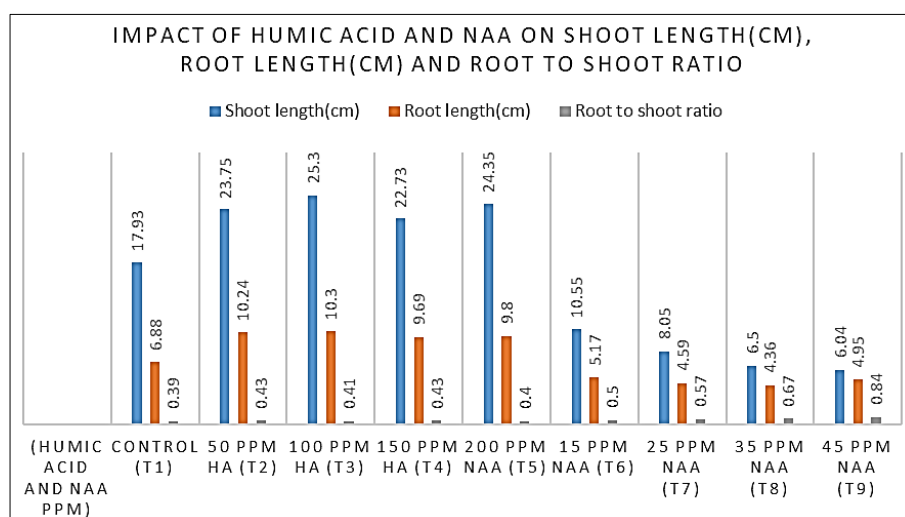


Fig 2: Impact of PGR on seedling dry weight, fresh weight, root to shoot ratio.

Conclusion

The study finds that soaking seeds in plant growth regulators, particularly humic acid at concentrations of 100 and 150 ppm, significantly enhances important seed performance metrics. These metrics include the germination rate, length of roots and shoots, seedling vigor, and both fresh and dry weights of the seedlings. In contrast, naphthalene acetic acid (NAA) exhibits negative impacts on germination rates and overall growth metrics. Therefore, humic acid is identified as a superior treatment choice for

enhancing seed performance when compared to NAA. This suggests that humic acid could be a valuable plant growth regulator in agricultural practices aimed at improving seed vigor and overall plant development.

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