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Effect of different plant growth regulators on the growth of transplanted rice (*Oryza sativa* L.)

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Abstract

In worldwide increasing population of future generation likewise their food needs also increased. So meet out their needs by rice production have a vital role. The productive potential of rice is mainly governed by many factors but deficiency of plant growth regulators (PGR) of plant develop a barrier to obtain higher yield. In this situation one of the newer technology to increase the productivity of rice through application of PGR on rice crop is helpful.The treatments are T_1 - Gibberellic acid 40% WSG @ 10 gm ha^{-1}, T_2 - Gibberellic acid 40% WSG @ 20 gm ha^{-1}, T_3 - Abscisic acid 20% SG @ 60 gm ha^{-1}, T_4 - Abscisic acid 20% SG @ 30 gm ha^{-1},T_5 - Humic acid 12% @ 12.5 l ha^{-1}, T_6 - Humic acid 12% @ 10 l ha^{-1}, T_7 - Triacontanol 0.05% EC @ 250 ml ha^{-1}, T_8 - Triacontanol 0.05% EC @ 150 ml ha^{-1}, T_9 - Untreated control. Growth regulators *viz.*, Gibberellic acid (GA_3), Humic acid, and Triacontanol were foliar sprayed at active tillering stage and Abscisic acid was foliar sprayed at early grain filling stage of crop growth. The result showed that foliar application of Humic acid 12% @ 12.5 l ha^{-1} (T_5) recorded the highest growth attributes *viz.*, plant height, number of tillers m^{-2}, root length, leaf area index, dry matter production and crop growth rate (CGR) compare to the control.

Keywords: Annamalai, growth parameters, growth regulators, humic acid, rice

1. Introduction

Rice (*Oryza sativa* L.) is a widely grown crop all around the world and is considered as the “global grain’’. It belongs to the family Poaceae and assumes considerable importance from the point of food and nutritional security in the world. The population of India is projected close to 1.6 billion in 2050 (Madhukeshwera *et al.*, 2018) [16], compare to 1.37 billion in 2020 (Worldometer, UN, 2020) [27]. The present food grain (cereals) production of India is 291.95 million tonnes (ET Bureau, 2019-2020) [5] and Federation of Indian Chambers of Commerce and Industry predicts food grain demand in India will reach around 355 million tonnes in 2030. Due to ever increasing population, the demand on rice production has also increased.The potential of production of rice is influenced by many factors like soil types, fertilizer used, irrigation, genotypes used for planting and different agronomic practices.The productivity of rice has to be increased through adoption of suitable and newer technologies (Badwai, 2004) [1]. Among them, important newer technology includes application of plant growth regulators on rice crop. Lack of PGR at any step of the plant could make it difficult to achieve significant grain yields (Pandey *et al.*, 2001) [20].

Plant growth hormones are produced naturally and play an important role in activating and inactivating gene expression, growth, and behavioral processes in plants. As a result, the introduction of chemical growth regulators has opened up new possibilities for modifying plant growth, development, and metabolism (Kumar *et al.*, 2018) [15]. Exogenously given hormones can also be stored in the form of reversible conjugates, which release active hormone when and where plants need it during the growth phase (Tiwari *et al.*, 2011) [23]. GA_3 is an excellent plant growth hormone that promotes cell elongation. In hybrid rice seed development, GA_3 is critical for achieving high seed yield (Gavino *et al.*, 2008) [7]. Triacontanol promising growth promoters have growth enhancing properties when applied to the leaves of growing plants. It is non-toxic plant growth bio-regulator without any residual effect. It develops stronger seedlings with a healthier root system, which grow into more vigorous plants with higher yields. Highest panicle length at harvest was obtained with treatments of triacontanol. Rice grain filling is one of the most important developmental process in cereals since the process directly determines final grain weight and yield (Kato *et al.*, 1993) [11]. Humic acid application by seedling dipping (0.3 per cent) and foliar application twice significantly improved the yield growth parameter of rice crop (Kavitha *et al.* 2010) [12].

Therefore, an experiment was conducted to find out the effect of plant growth regulators on growth of rice.

2. Materials and Methods

Field experiment was conducted at the Experimental Farm, Department of Agronomy, Faculty of Agriculture, Annamalai University, Annamalai Nagar, Tamil Nadu, and India during Navarai season (January-April, 2019) to study the effect of different plant growth regulators on growth and yield of transplanted rice. The soil was clayey with pH 7.6 available nitrogen 235 kg/ha phosphorus 17.80 kg/ha and exchangeable potassium 320 kg/ha. The rice variety chosen for study is CO 47 for *Navarai* season. The experiment was laid out in Randomised Block Design (RBD) with nine treatments and three replications. The details of the treatments were given below.

T_1 - Gibberellic acid 40% WSG @ 10 gm ha^{-1}
T_2 - Gibberellic acid 40% WSG @ 20 gm ha^{-1}
T_3 - Abscisic acid 20% SG @ 60 gm ha^{-1}
T_4 - Abscisic acid 20% SG @ 30 gm ha^{-1}
T_5 - Humic acid 12% @ 12.5 l ha^{-1}
T_6 - Humic acid 12% @ 10 l ha^{-1}
T_7 - Triacontanol 0.05% EC @ 250 ml ha^{-1}
T_8 - Triacontanol 0.05% EC @ 150 ml ha^{-1}
T_9 - Untreated control

Growth regulators were foliar sprayed at different stages of crop growth Gibberellic acid at active tillering stage, Abscisic Acid at early grain filling stage, both Humic acid and Triacontanol were applied at active tillering stage during morning hours with hand operated knapsack sprayer.

Plant height was measured from ground level to the tip of the top most leaf at tillering, flowering and at harvesting stages from five randomly selected plants. The number of tiller m^{-2} was recorded by counting at maximum tillering stage of the crop. Leaf area index (LAI) of rice at tillering and flowering was worked out by the method suggested by Palaniswamy and Gomez (1974) [19]. The root length was measured from the base of the plant to the root tip individually at flowering stage. Five plant samples were taken at random from the border rows of each plot at tillering, flowering and at harvest stages. These samples were first air dried and then oven dried at 70°C till a constant weight was obtained. The mean dry weight was recorded and expressed in kg ha^{-1}. The Crop Growth Rate explains the dry matter accumulated per unit land area per unit time, expressed as g m^{-2} day^{-1}. It was calculated by using the following formula as suggested by Watson (1958) [26]. The data on various characters studied during the course of investigation were statistically analyzed as suggested by Gomez (1984) [8]. Whenever the results were significant, the critical difference was worked out at 5% probability level to draw statistical conclusions.

3. Results and Discussion

3.1. Plant height (cm): The plant height was significantly influenced by application of plant growth regulators over the control (T_9) at different stages of crop growth (Table 1). Among the various growth regulators, foliar application of Humic acid 12% @ 12.5 l ha^{-1} (T_5) recorded the highest plant height of 64.80, 84.21 and 94.40 cm at tillering, flowering and harvest stages, respectively as shown in (Figure 1). The least plant height of 49.21, 64.80 and 72.41 cm was recorded under treatment T_9 – control at all the stages of crop growth. This finding was in agreement with Osman *et al.*, (2013) [18] who stated that foliar application of Humic acid and fulvic acid together significantly increased the plant height. Influence of Humic acid that can stimulate plant growth due to the presence of vitamins, amino acids, gibrellines and auxin like growth promoting substances (O'Donnell, 1973) [17]. Plant height is an important agronomic trait of rice that closely related to biomass production and yield of the crop (Zhang *et al.*, 2017) [29].

3.2. Number of tillers m^{-2}: Number of tillers m^{-2} was significantly influenced by application of plant growth regulators over the control (T_9) at active tillering stage of rice (Table 1). Among the various growth regulators, foliar application of Humic acid 12% @ 12.5 l ha^{-1} (T_5) recorded the highest number of tillers m^{-2} of 412.12 at active tillering stage of rice. The least number of tillers m^{-2} of 315.01 was recorded under treatment T_9-control at active tillering stage of rice crop. Number of tillers is a dominant agronomic trait for panicle number per unit area as well as rice grain production and dry weight (Badshah *et al.*, 2014) [2]. The findings were close in agreement with Kumar *et al.*, (2014) [14], who observed that application of potassium humate caused significant increase in plant height and number of tillers in rice crop. The number of tillers was vastly improved after foliar spraying with synthetic auxin (NAA) (Jahan and Adam, 2011) [9].

3.3. Leaf Area Index (LAI): The leaf area index at tillering and flowering stages were significantly increased by application of plant growth regulators over the control (T_9) in Navarai season (Table 1). Data indicated that among the various growth regulators, the foliar application of Humic acid 12% @ 12.5 l ha^{-1} (T_5) recorded the highest leaf area index of 2.63, 5.01 at tillering and flowering stages, respectively. The least leaf area index of 1.94 and 3.92 was recorded under absolute control (T_9) at tillering and flowering stages, respectively.LAI is a structural feature of vegetation that indicates the area of ground occupied by plants. The principal sites of energy and mass exchange, as well as other critical processes like canopy interception, evapotranspiration, and gross photosynthesis, are all directly proportional to LAI (Fang and Liang, 2014) [6]. The findings are also in line with those of Vanitha and Mohandas (2014) [25], who found that rice containing 100% RDF and humic acid had the highest LAI.

3.4. Root length (cm): Root length of rice at flowering stage was significantly increased by application of plant growth regulators over the control (Table 1). Among the various growth regulators, foliar application of Humic acid 12% @ 12.5 l ha^{-1} (T_5) recorded the highest root length of 25.12 cm at flowering stage of rice. The least root length of 17.40 cm was recorded under treatment T_9 – control at flowering stage. The effects of humic chemicals on plants are frequently greater on roots than on shoots, according to Chen and Aviad (1990) [16]. Stimulation of root growth, increased proliferation of root hairs, and enhancement of root initiation by humic acids has been reported commonly by several other researchers (Tattini *et al.*, 1991) [22]. Humic acid increased level of growth promoting substance (O'Donnell, 1973) [17] which increased the root length, root volume, root weight of rice by cell division and cell elongation (Sarker *et al.*, 2010) [21].

3.5. Dry matter production (DMP) (kg ha^{-1}): The DMP was highly enhanced at all stages of rice growth due to application of plant growth regulators over the control (T_9) at different stages of crop growth (Table 1). Perusal of data revealed that among the various growth regulators incorporated, foliar application of Humic acid 12% @ 12.5 l ha^{-1} (T_5) recorded the highest DMP of 1319 kg ha^{-1} at tillering, 7381 kg ha^{-1}atflowering and 12636 kg ha^{-1} at harvest stages of rice. (Figure 2).The highest DMP was the result of increased efficiency of photosynthetic apparatus, which was manifested by (1) a higher leaf area, (2) an increase in the intensity of photosynthesis, (3) higher chlorophyll content (Kazda *et al*., 2015) [13] and the leaf area index particularly at reproductive stage play specific role in dry matter production of rice (Balamurugan *et al*., 2018) [3]. Deepa and Govindarajan (2002) [4] found highest DMP in Humic acid. The overall functions of the plant ultimately lead to progressive accumulation of the dry matter in the plant body. All the physiological process resulted in accumulation of dry matter (Kamble, 2015) [10].

3.6. Crop growth rate (CGR) (g m^{-2} day^{-1}): The CGR at tillering to flowering and flowering to harvest stages was significantly increased by application of plant growth regulators over the control (Table 1). Among the various growth regulators, foliar application of Humic acid 12% @ 12.5 l ha^{-1} (T_5) recorded the highest CGR of 20.21 and 11.68 g m^{-2} day^{-1} at tillering to flowering and flowering to harvest stages, respectively. The least CGR of 14.68 and 7.17 g m^{-2} day^{-1} was recorded under absolute control (T_9) at tillering to flowering and flowering to harvest stages, respectively. Balamurugan *et al*. (2018) [3] also reported that crop growth rate was altered with the age of the crop due to gradual changes in photosynthetic efficiency. This was confirmed in the present study that the CGR at flowering to harvest stages decreased gradually, when compared to tillering to flowering stages. Humic acid increased the endogenous auxin content (O'Donnell, 1973) [17].

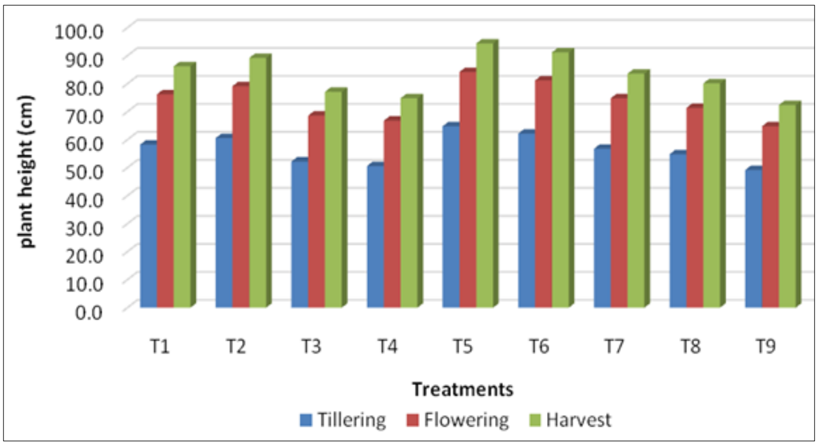

Fig 1: Effect of plant growth regulators on plant height of rice

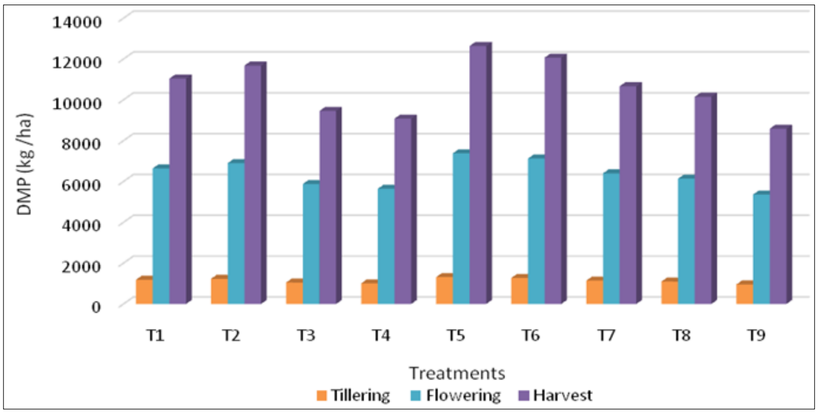

Fig 2: Effect of plant growth regulators on dry matter production of rice

4. Conclusions

From the experimental results, it was found that application of Humic acid 12% @ 12.5 l ha^{-1} (T_5) increased the growth attributes. Therefore, it concluded that application of humic acid 12% @ 12.5 L ha^{-1} (T_5) was found to be agronomical superior, economically sustainable and ecologically viable practice for cultivation of rice.

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