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Influence of humic acid foliar spray on physiological growth indices in Redgram *(Cajanus cajan*)

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ABSTRACT
In order to investigate the interactive effect of foliar spray of humic acid on physiological Indices of growth in Redgram (Cajanus cajan).The study was conducted during Kharif 2013-14 at Main Agricultural Research Station, UAS, Raichur by using randomized block design. The effectiveness of humic acid was studied with different levels as T_1 - Humic acid liquid 15% @ 1.0 ml/l of water, T_2 - Humic acid liquid 15% @ 1.5 ml/l of water, T_3 - Humic acid liquid 15% @ 2.5 ml/l of water, T_4 - Humic acid liquid 15% @ 4.0 ml/l of water, T_5 - Planofix 4.5 % @ 20ppm and T_6 - as a control. After the collection of data from redgram at different growth stage i.e. 30, 60, 90 DAS and at harvest all the physiological growth indices including total leaf area , Leaf area index (LAI), total dry weight (TDW), ,relative crop growth rate ,crop growth rate (CGR), net assimilation rate (NAR), leaf area duration were measured. Significant differences (p<0.5) were observed for all the above mentioned growth parameters across the humic acid concentration levels. Changes trend of total leaf area, Leaf area duration, leaf area index and total dry matter significantly increased while the increased in concentration of humic acid foliar spray. LAI, LAD and NAR, like other growth indices, responded to the foliar sprays of humic acid and contributing the positive responses for increase in yield of redgram crops.
***Keywords**: Humic acid, growth indices, total dry matter, leaf area index, NAR, and LAD*

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INTRODUCTION

Pulses as one of the most important plant resources are full of protein and after grains are considered as the second most important source of food for human being. The rate of protein in legumes grains is twice or three times more than that of grain cereals and 10 to 20 times more than that of tuberous crops like potatoes [11]. Pigeonpea (*Cajanus cajan*) is cultivated on an about 4.23 million hectares in the world with annual production of 2.96 million tonnes and a productivity of 700 kg ha^{-1}. It is an important pulse crop in India, which accounts for an about 90 per cent (3.58 m ha) of the total world area and production (2.72 m tons) with a productivity of 844 kg ha^{-1}. In Karnataka, pigeonpea occupies second place in area (0.68 m ha) and production (0.28 m tons) with a productivity of 712 kg per ha [2]. Gulbarga called as dalbowl, is a very potential district in the Northern Karnataka state for extensive cultivation of pigeonpea.Pigeonpea is intrinsically perennial, but it is generally grown as an annual crop. The initial vegetative growth take place during the monsoon and floral initiation to end of grain filling phase occurs in winter season; which is generally dry and the pigeonpea crop depend for their continued development on stored moisture. As a result, redgram consumption in most of the low income countries like India has increased from 22% - 66%. Despite all these achievements, yields for the rainfed area are generally low and variable due to sparse, erratic rainfall and marginal soils.

Humic acid is extracted from different sources such as soil, Humus, peat, oxidized lignite, and coal. Humic acid can directly have positive effects on plant growth and increases the growth of shoots and roots, absorption of nitrogen, potassium, calcium, magnesium, and phosphorus by plant. Humic acid is consistent with nature and is not dangerous for the plant and environment [10]. [1] States that humic acid increases plant growth through chelating different nutrients to overcome the lack of nutrients, and has useful effects on growth increase, production, and quality improvement of agricultural products due to having hormonal compounds. Among legume family plants, humic acid foliar spray has remarkable effects

on vegetative growth of plant and increases photosynthetic activity and leaf area index. [9] The results of the research on wheat showed that the interactive effect of different concentrations of humic acid at three foliar spraying times on leaf area was significant [13]. [14] Stated that humic acid could sustain photosynthetic tissues and thus total dry weight would increase. Potassium is very important as one of the macronutrients and even though it is not a part of plant structure, it has a key role in internal reactions of the plant, so that it is called quality element. This research aimed to investigate the effect of foliar application of humic acid on growth trend of tur crop and determining the best application level of humic acid for increasing the yield potential of crop.

MATERIAL AND METHODS

A field experiment was conducted to find out effect of foliar application different levels of humic acid on physiological Indices of growth in Redgram during Kharif 2013-14 at Main Agricultural Research Station, MARS, Raichur. The data of prevailing climatic parameters were collected from research centre meteorological station which is located within one kilometer from experimental area. The crop was sown on 17th July, 2013 by manual line sowing 90 cm row spacing and 30 cm between plants. The redgram variety selected for the study was TS-3R released by University of Agricultural Sciences, Raichur. It is a high yielding variety. The humic acid was sprayed three times at 60-90 days after sowing, at the time of flowering and pod development stage. The concentration of Humic acid for each treatment was sprayed at different levels. The observations on various physiological indices viz., Leaf area, Leaf Area Index, Crop Growth Rate, Relative growth rate, Net Assimilation Rate , LAD and Harvest index , as estimated by methods devised by [18], [19], [16], [23], [17], [20], and [6] , respectively. The analysis and interpretation of the experimental data was done as suggested by [21], with level of significance used as P = 0.05.

RESULT AND DISCUSSIONS

Leaf area (cm^2 per plant) and total dry matter production

The data pertains to leaf area total dry weight trend (Fig. 1 & 2) shows that at different growth stages, total dry weight of plant has increased gradually and all the treatments differ significantly to each other. As it is observed, total dry weight of redgram plant in treatment with 4.0 ml /l of water humic acid is more than that of other treatments. This shows that as humic acid concentration increases, total dry weight also increased. The results of this study are conformity with the findings of [10] in Horsegram , [15] in tomato stated that humic acid could improved the activity of photosynthetic tissues in crop plant and thus leaf area & total dry weight would increases at all the stages . All levels of humic acid 98 days after sowing maximized leaf area & dry matter accumulation and then they showed a descending trend. The plant sown its accumulated dry matter into reproductive organs, and the loss of leaves led to decrease of dry matter accumulation. The highest descending trend was observed in control treatments due to lack of absorption of humic acid by the leaves . [12] showed that application of humic acid foliar sprays had a key role in increasing the yield. The results were consistent with the findings of [25] in potato and [26] in maize and [5] in soybean .

Leaf Area Index

With regard to (Fig. 3), the highest leaf area index was obtained after applying 4.0 ml /l of water of humic acid at vegetative growth stage in comparison to other treatments and the lowest leaf area index was related to the control treatment. [5] has done experiment to see the Effects of different Levels and Application Times of humic acid on root and Leaf Yield and Yield components of forage turnip and stated that that as humic acid increases plant growth through chelating different nutrients to overcome the lack of nutrients, and has useful effects on growth increase, production, and quality improvement of agricultural products due to having plant growth hormonal compounds. [9] Studied in corn and stated that in legume plants, humic acid foliar spray has remarkable effects on vegetative growth of plant and increases photosynthetic activity and leaf area index. [10] investigated the effect of humic acid on growth parameters of cowpea and found that humic acid would increase leaf area index and this is directly indicating the good crop growth throughout the crop period.

Crop Growth Rate (CGR)

In the experimental treatment combination with foliar application of 4.0 ml /l of water , humic acid, crop growth rate was more than other treatments and increasing trend of crop growth rate is observed at all the stages (Fig. 6) . This trend is due to gradual increase of absorbing solar radiation together with increase of green cover percentage at the beginning of growth season and consequently the increase of dry matter accumulation in plants. As it is observed in other treatments when the leaves get old and the rate of dry mater accumulation decreases then crop growth rate also decreases. The decrease of crop growth rate at harvest could be due to decrease of plant dry matter because of the fall of leaves. Generally,

crop growth rate depends on canopy photosynthesis per area unit of land. The results of this part are consistent with the findings of [10] in horsegram and [7] in maize, as the increase in the concentration of humic acid increased the crop growth rate till flowering stage and pod filling stage and then CGR decreased up to harvesting.

Relative Growth Rate

Changes trend of relative growth rate at different levels of humic acid is shown in (Fig. 5). It is a first initial stage of the crop growth increasing and then decreasing relative growth rate trend was observed because as the time passes plant weight increases and consequently the number of tissues which have died or which are quite mature and do not have any role in production will increase, too. In other words, at the beginning of growth, all plant weight and cells play some roles in production but dead tissues and cells that play no role in production will increase over the time. The decrease of relative growth rate of plants during the growth season is due to increase of structural tissues in comparison to photosynthetic tissues. Shadowing, leaf senescence and aging of lower leaves of plant canopy also somewhat affects such drop of old leaves. However, the treatment with 4.0 ml /l of water , humic acid has sustained plant growth more than other treatments. The results were similar to existing research findings of [10] in horsegram and [4] during seed germination of different crop.In line, [14] also reported that sprayed 50 to 300 mg per kg humic acids on the soil in a pot experiment with maize and found that the addition of 50 and 100 mg kg−1 caused a significant increase of 10 and 15% in relative growth rate in maize plant.

Net Assimilation Rate (NAR) and LAD

Changes trend of net assimilation rate (NAR) and LAD at different levels of humic acid is shown in (Fig. 7 and Fig. 4). As it is observed, with increasing trend of days after sowing, cumulative NAR and LAD values increasing upto peak growth period then gradual decreasing trend was observed up to harvesting.The highest NAR and LAD values were achieved by the foliar application of humic acid @ 4.0 ml /l of water. NAR index, like other growth indices, responded to the exogenous application of humic acid. The results of experiments [8] in cotton showed that as the plant gets older NAR decreases due to leaves senescence and aging and their shadows on each other and decrease of the activity of photosynthetic tissues in crop plant. When all other leaves are exposed to sunlight completely, NAR and LAD values are maximized, that's the final crop yield increases with increasing the concentration of humic acid . Similalarly [23] with study effects of mineral fertilizers and humic substances on growth and yield of cowpea were reported that, combination of chemical fertilizer with application of humic substances improve growth and yield of cowpea.

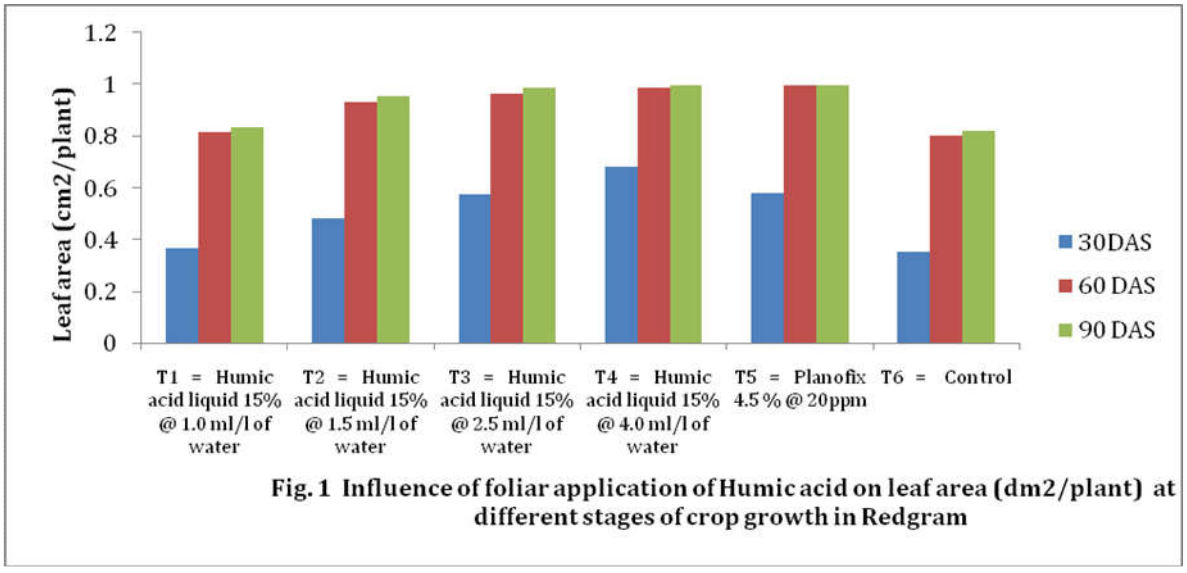

Fig. 1 Influence of foliar application of Humic acid on leaf area (dm2/plant) at different stages of crop growth in Redgram

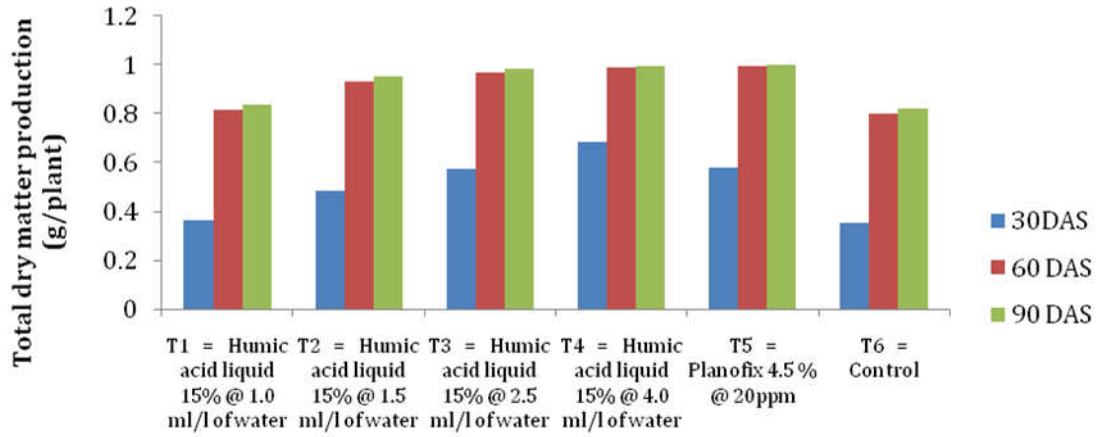

Fig. 2 Influence of foliar application of Humic acid on Total dry matter production (g/plant) at different stages of crop growth in Redgram

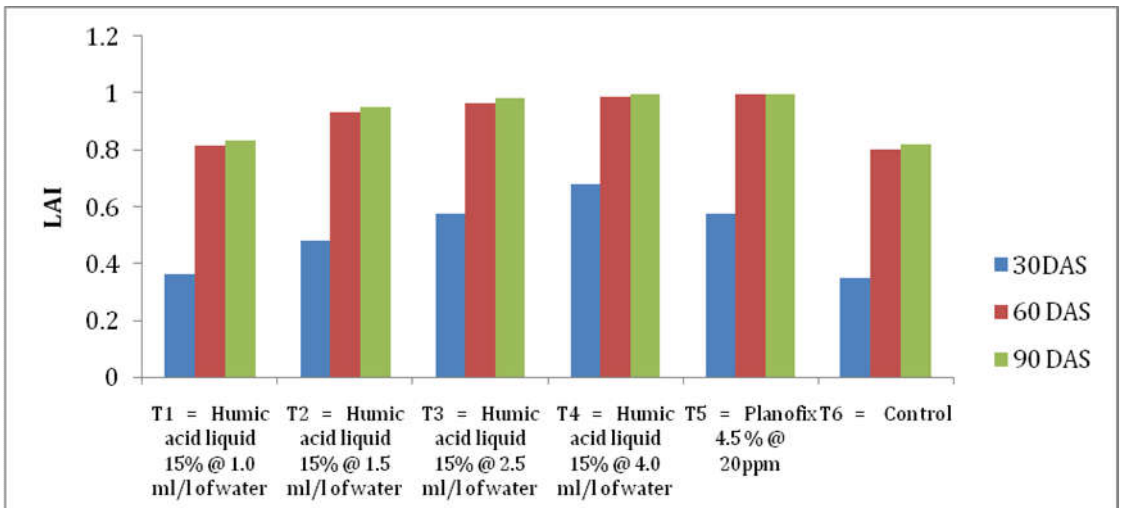

Fig.3 Influence of foliar application of Humic acid on leaf area index (LAI) at different stages of crop growth in Redgram

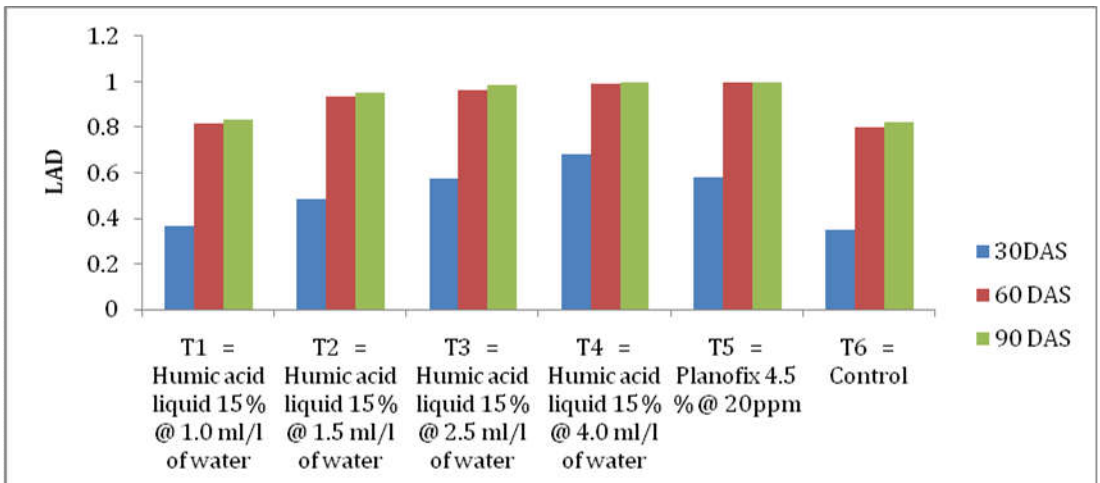

Fig. 4 Influence of foliar application of Humic acid on Leaf Area Duration (Days) at different stages of crop growth in Redgram

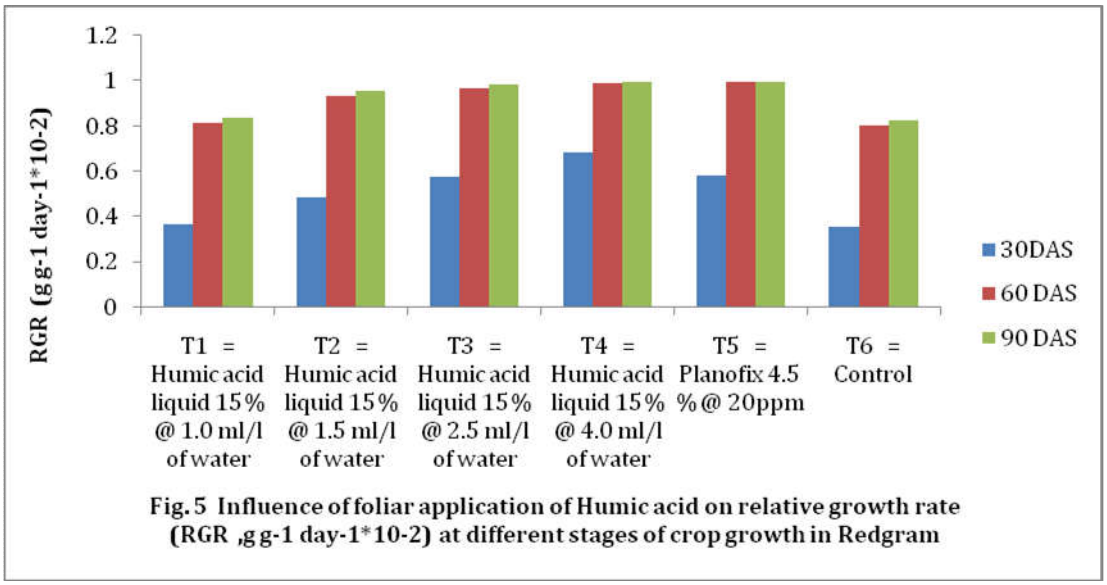

Fig. 5 Influence of foliar application of Humic acid on relative growth rate (RGR ,g g-1 day-1*10-2) at different stages of crop growth in Redgram

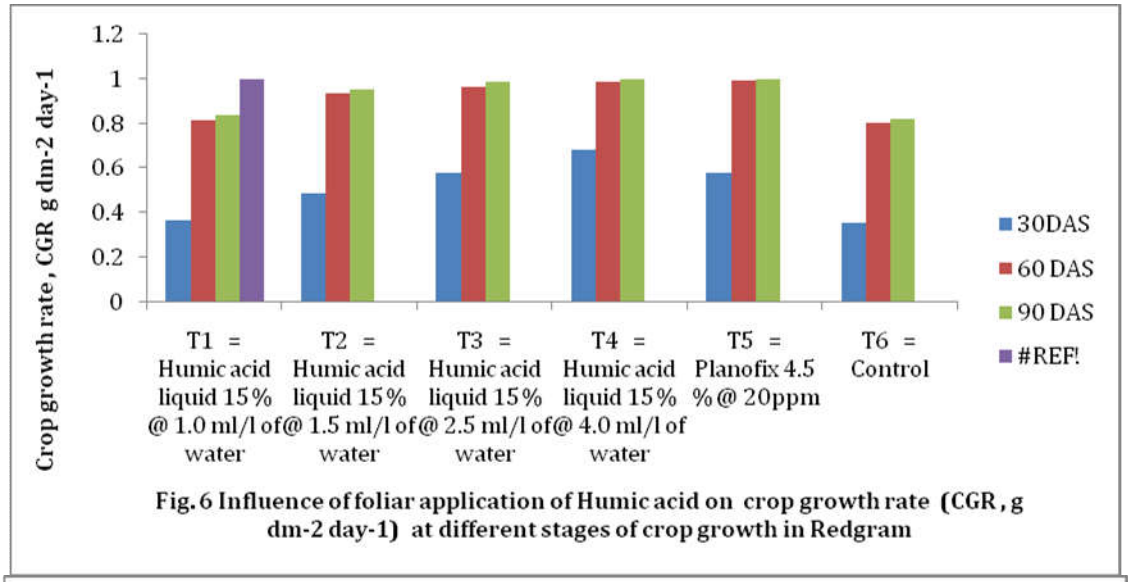

Fig. 6 Influence of foliar application of Humic acid on crop growth rate (CGR , g dm-2 day-1) at different stages of crop growth in Redgram

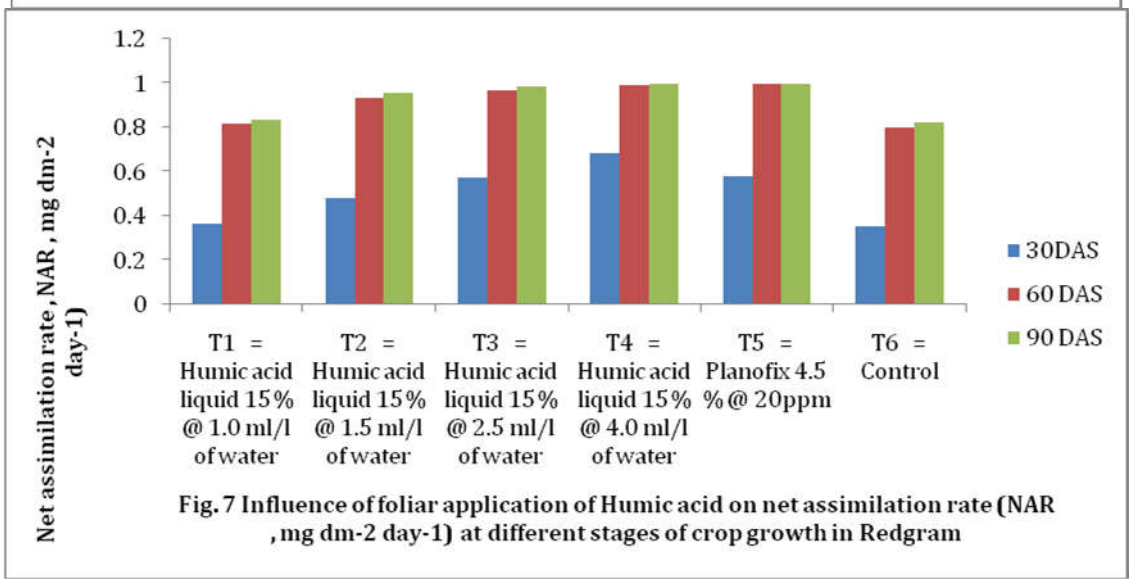

Fig. 7 Influence of foliar application of Humic acid on net assimilation rate (NAR , mg dm-2 day-1) at different stages of crop growth in Redgram

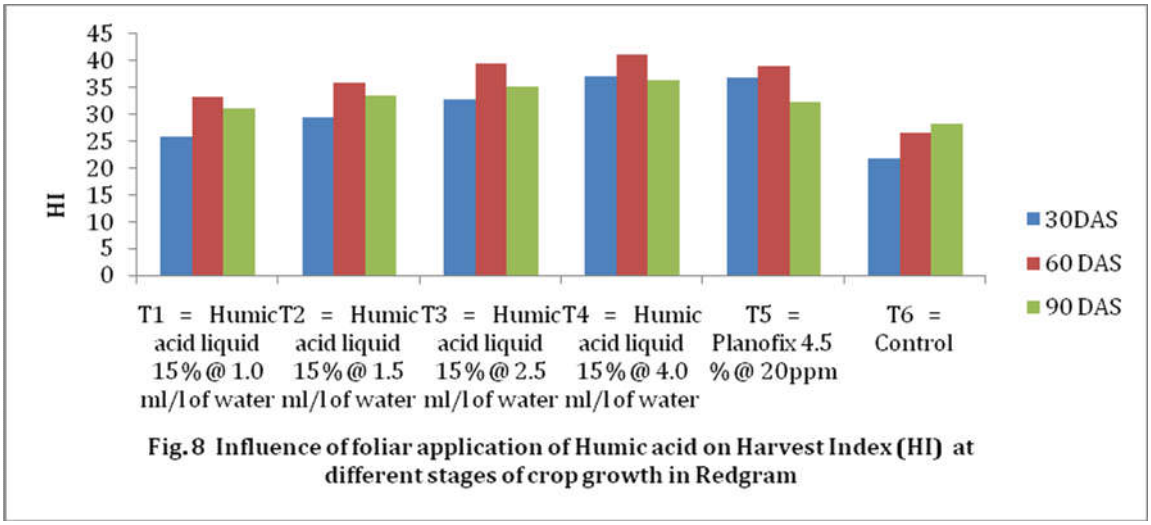

Fig. 8 Influence of foliar application of Humic acid on Harvest Index (HI) at different stages of crop growth in Redgram

CONCLUSIONS

Application of humic acid substances at the start of the growing season induced an overall positive effect on growth, development and dry matter yield of redgram in the field.. The application of Humic acid Liquid 15% @ 4.0ml/L at flower bud formation stage may reduce flower drops in redgram compared to control. It was also observed that the foliar application of all the doses of Humic acid Liquid 15% on redgram significantly increased the all the morpho- physiological parameters and showed positive effects on the vegetative growth of the plants that's finally improving the crop yield. Increment in Humic acid concentration increased growth and quality of redgram in the present study. Based on the present study findings Humic acid Liquid 15% @ 4.0ml/l foliar application to may be recommended. Further research is required in diverse plant environments to determine economically feasible application level of Humic acid while comparing it with other manures and organic fertilizer sources.

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