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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 influence of humic acid foliar spray on physiological growth indices in Redgram (Cajanus cajan). The study was conducted during Kharif 2018-2019 at Main Agricultural Research Station, UAS, Raichur by using a randomized block design. The effectiveness of humic acid was studied with different levels as T1 - Humic acid liquid 15% @ 1.0 ml/l of water, T2 - Humic acid liquid 15% @ 1.5 ml/l of water, T3 - Humic acid liquid 15% @ 2.5 ml/l of water, T4 - Humic acid liquid 15% @ 4.0 ml/l of water, T5 - Planofix 4.5 % @ 20ppm and T6 - as a control. After the collection of data from redgram at different growth stages 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 the concentration of humic acid foliar spray. LAI, LAD, and NAR, like other growth indices, responded to the foliar sprays of humic acid and contributed the positive responses for an increase in the yield of redgram crops.

Keywords: *Humic acid, growth indices, total dry matter, leaf area index, NAR, and LAD*

INTRODUCTION

Pulses as one of the most important plant resources are full of protein and grains are considered the second most important source of food for human beings. The rate of protein in legume 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 about 4.23 million hectares in the world with an 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 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, pigeon pea occupies second place in the area (0.68 m ha) and production (0.28 m tons) with a productivity of 712 kg per ha [2]. Gulbarga called as dal bowl, is a very potential district in the Northern Karnataka state for extensive cultivation of pigeon pea. Pigeonpea is intrinsically perennial, but it is generally grown as an annual crop. The initial vegetative growth takes place during the monsoon and floral initiation to the end of the grain filling phase occurs in the winter season; which is generally dry and the pigeon pea crop depend for their continued development on stored moisture. As a result, program 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, and absorption of nitrogen, potassium, calcium, magnesium, and phosphorus by the plant. Humic acid is consistent with nature and is not dangerous for the plant 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, the humic acid foliar spray has remarkable effects on the vegetative growth of plants 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 the 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 the internal reactions of the plant, so it is called a quality element. This research aimed to investigate the effect of foliar application of humic acid on the growth trend of tur crops and determine the best application level of humic acid for increasing the yield potential of the crop.

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METHODOLOGY

A field experiment was conducted to find out the effect of foliar application of different levels of humic acid on physiological Indices of growth in Redgram during Kharif 2015-2016 at Main Agricultural Research Station, MARS, Raichur. The data of prevailing climatic parameters were collected from the research center meteorological station which is located within one kilometer from the experimental area. The crop was sown on 17th July, 2015 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 the 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 the level of significance used as P = 0.05.

RESULT AND DISCUSSIONS

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

The data pertaining to the leaf area total dry weight trend (Fig. 1 & 2) shows that at different growth stages, total dry weight of the plant has increased gradually and all the treatments differ significantly to each other. As it is observed, the total dry weight of the 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 in conformity with the findings of [10] in Horsegram, [15] in tomato stated that humic acid could improve the activity of photosynthetic tissues in crop plant and thus leaf area & total dry weight would increase 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 the 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 potatoes 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 the vegetative growth stage in comparison to other treatments and the lowest leaf area index was related to the control treatment. [5] has done an 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 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, the humic acid foliar spray has remarkable effects on the vegetative growth of plants and increases photosynthetic activity and leaf area index. [10] investigated the effect of humic acid on the growth parameters of cowpea and found that humic acid would increase leaf area index and this is directly indicating 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 , and humic acid, crop growth rate was more than other treatments and an 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 the 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 matter accumulation decreases then the crop growth rate also decreases. The decrease of crop growth rate at harvest could be due to the 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 horse gram and [7] in maize, as the increase in the concentration of humic acid increased the crop growth rate till the 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 the first initial stage of the crop growth increasing and then decreasing relative growth rate trend was observed because as 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 role in production but dead tissues and cells that play no role in production will increase over time. The decrease in the relative growth rate of plants during the growing season is due to an increase of structural tissues in comparison to photosynthetic tissues. Shadowing, leaf senescence, and aging of lower leaves of plant canopy also somewhat affects such drops 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 horse gram 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 the 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 plants. 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. Similarly [23] with study effects of mineral fertilizers and humic substances on growth and yield of cowpea were reported that a combination of chemical fertilizer with the application of humic substances improve the growth and yield of cowpea.

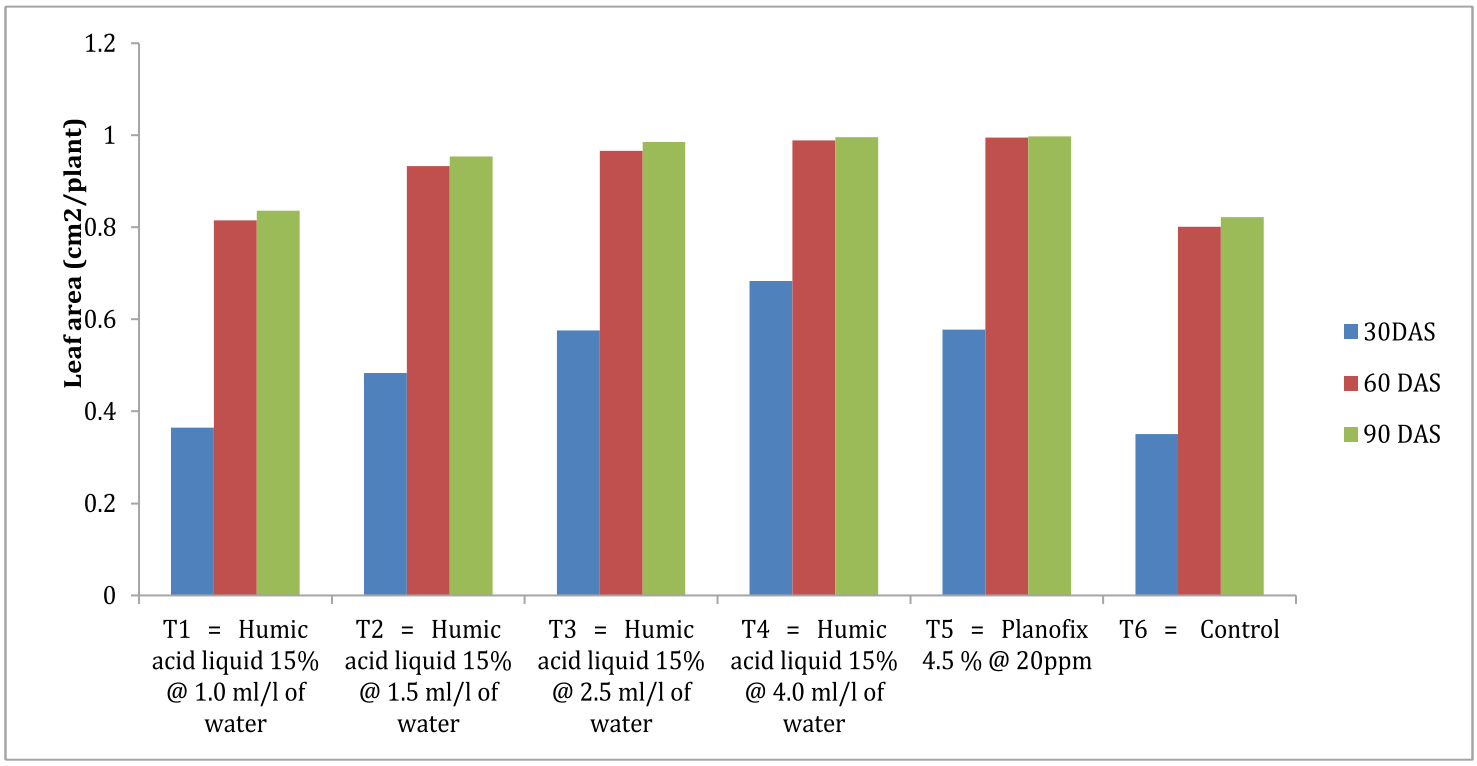

Fig. 1 Influence of foliar application of Humic acid on leaf area (dm2/plant) at different stages of crop growth in Redgram

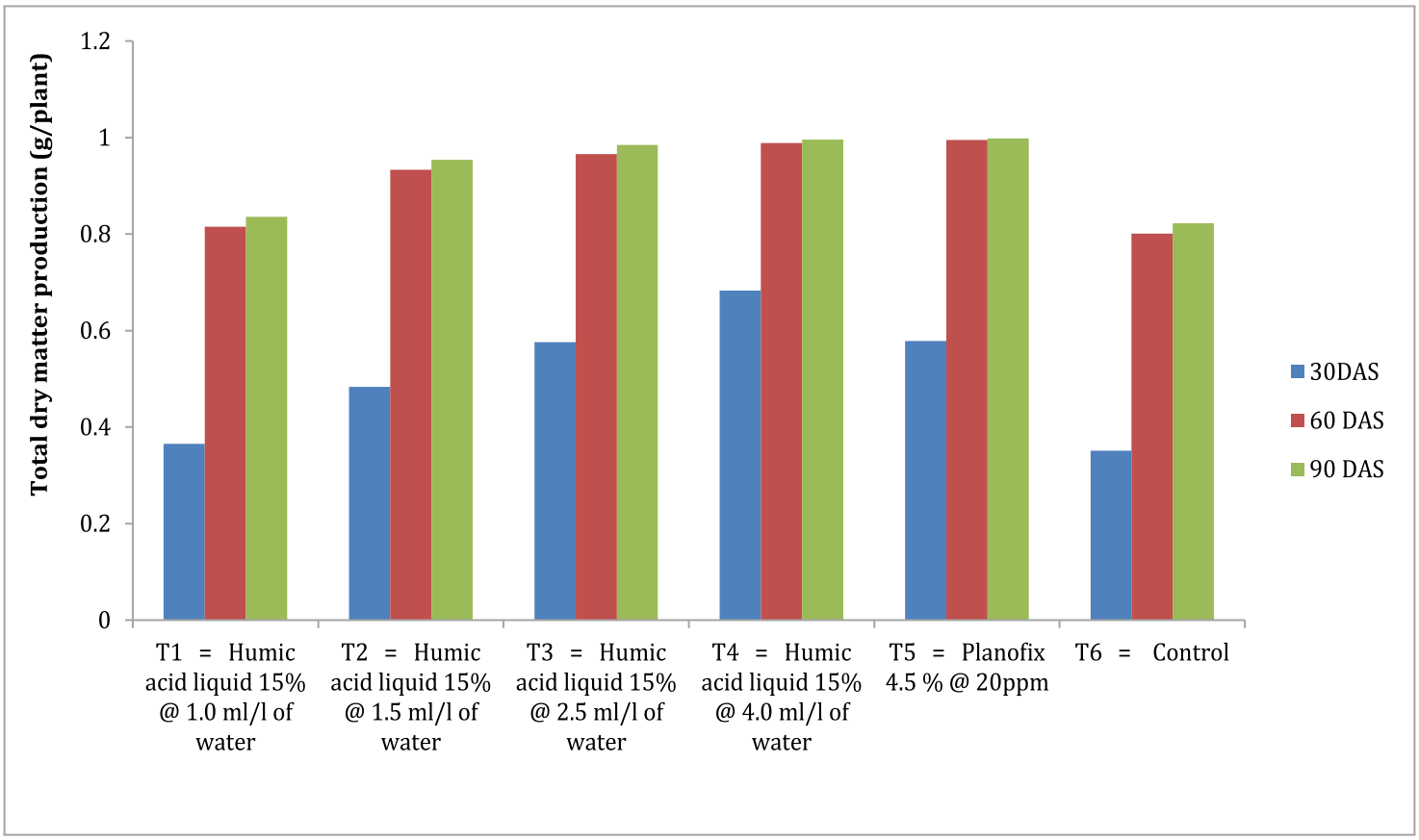

Fig. 2 Influence of foliar application of Humic acid on Total dry matter production (g/plant) at different stages of crop growth in Redgram

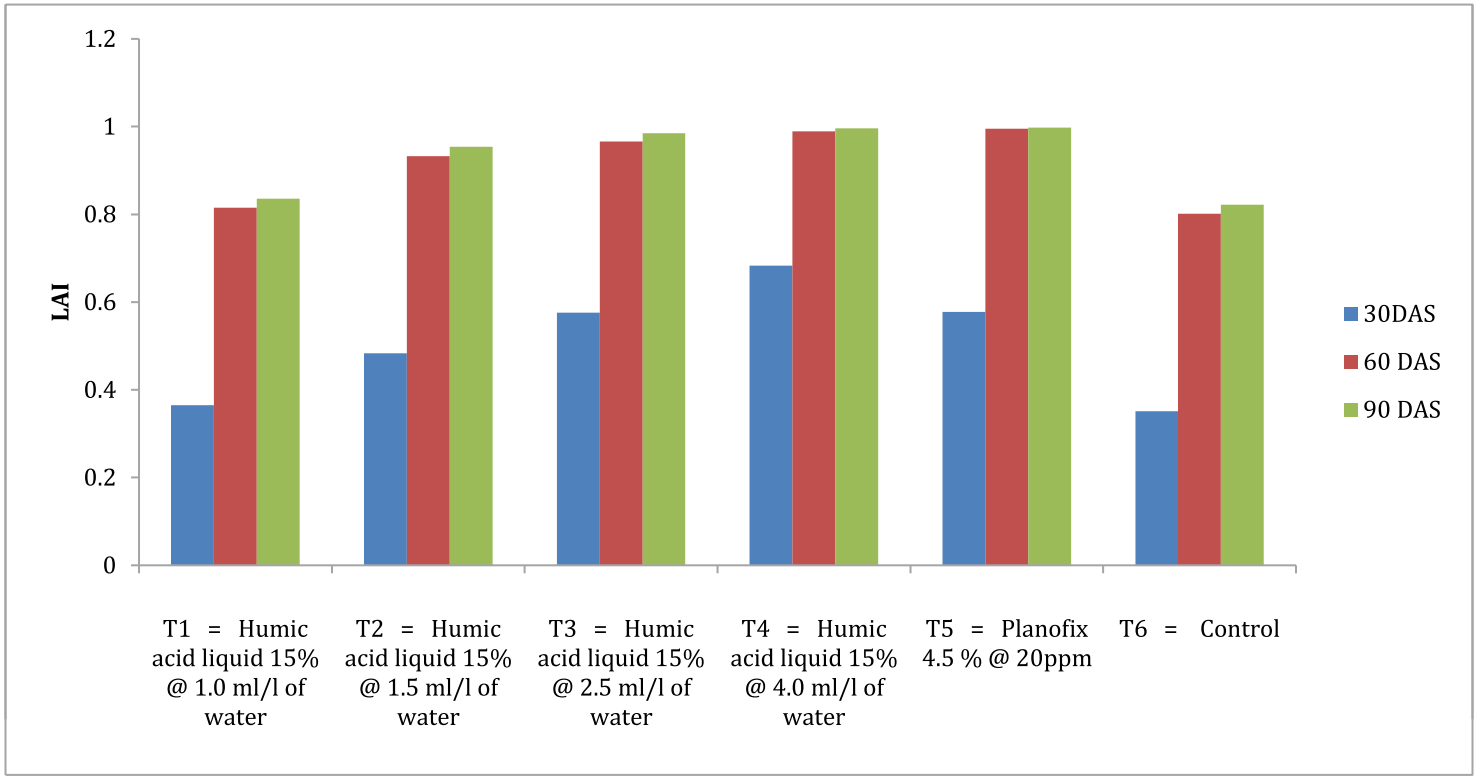

Fig.3 Influence of foliar application of Humic acid on leaf area index (LAI) at different stages of crop growth in Redgram

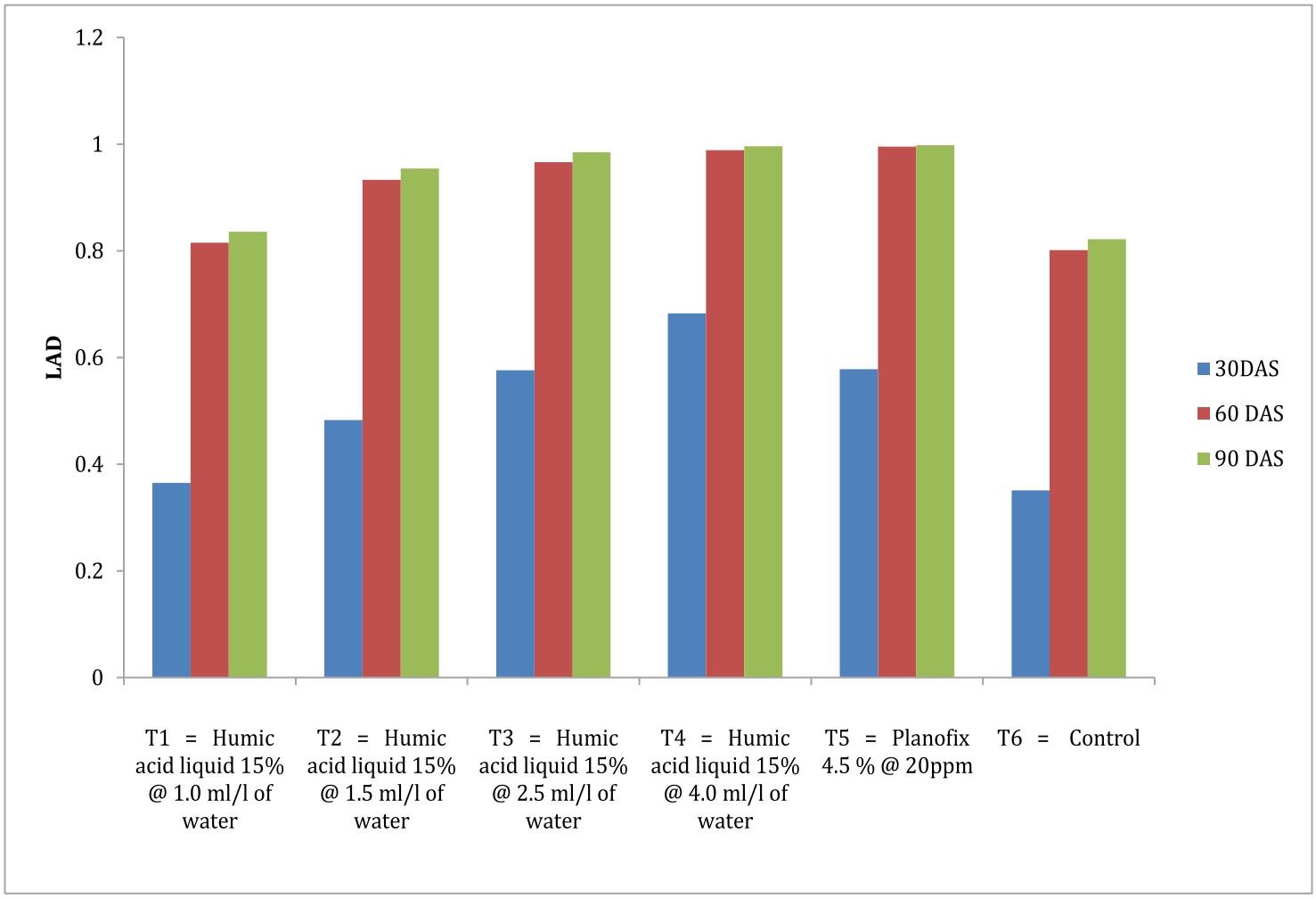

Fig. 4 Influence of foliar application of Humic acid on Leaf Area Duration (Days) at different stages of crop growth in Redgram

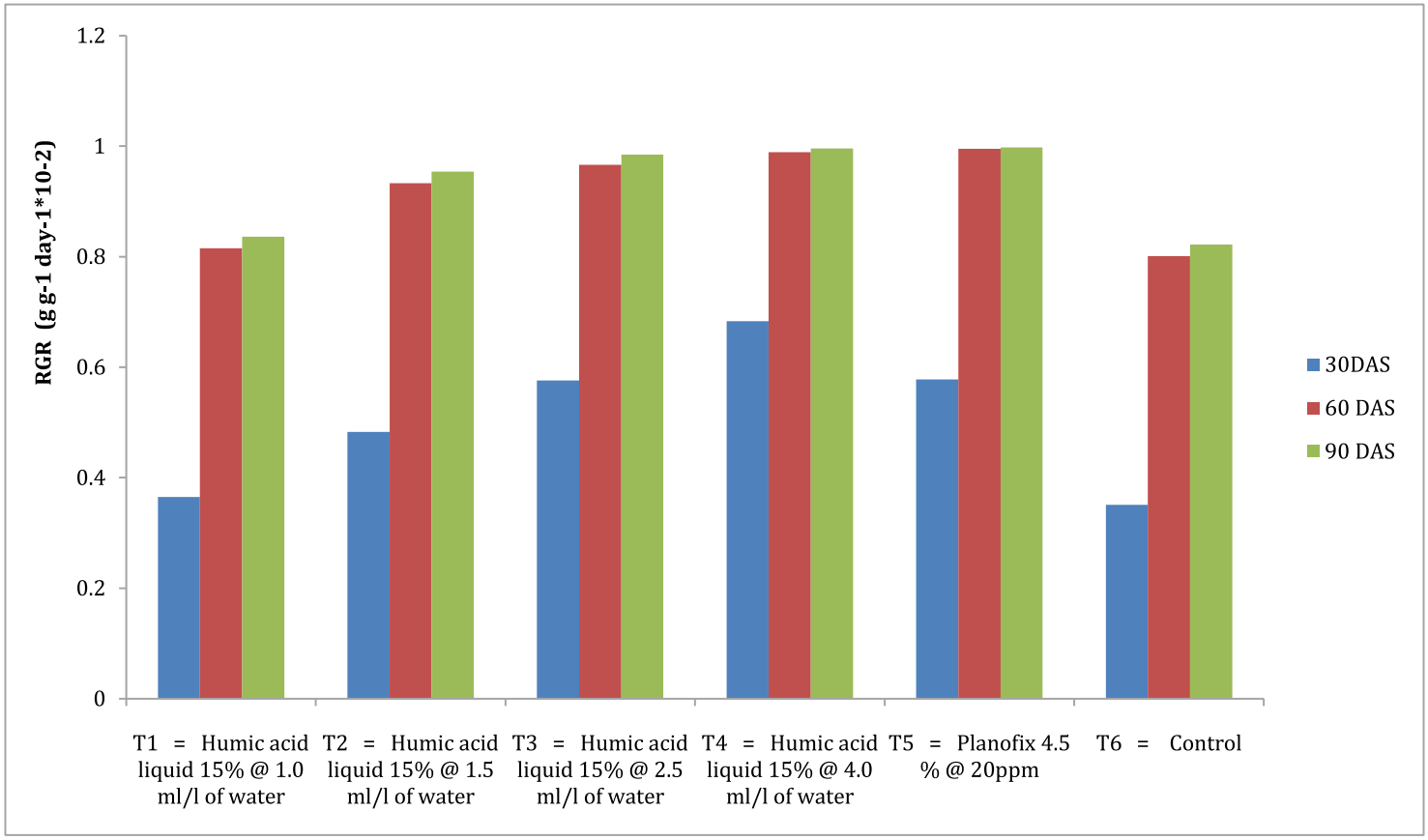

Fig. 5 Influence of foliar application of Humic acid on relative growth rate (RGR ,g g-1 day-1*10-2) at different stages of crop growth in Redgram

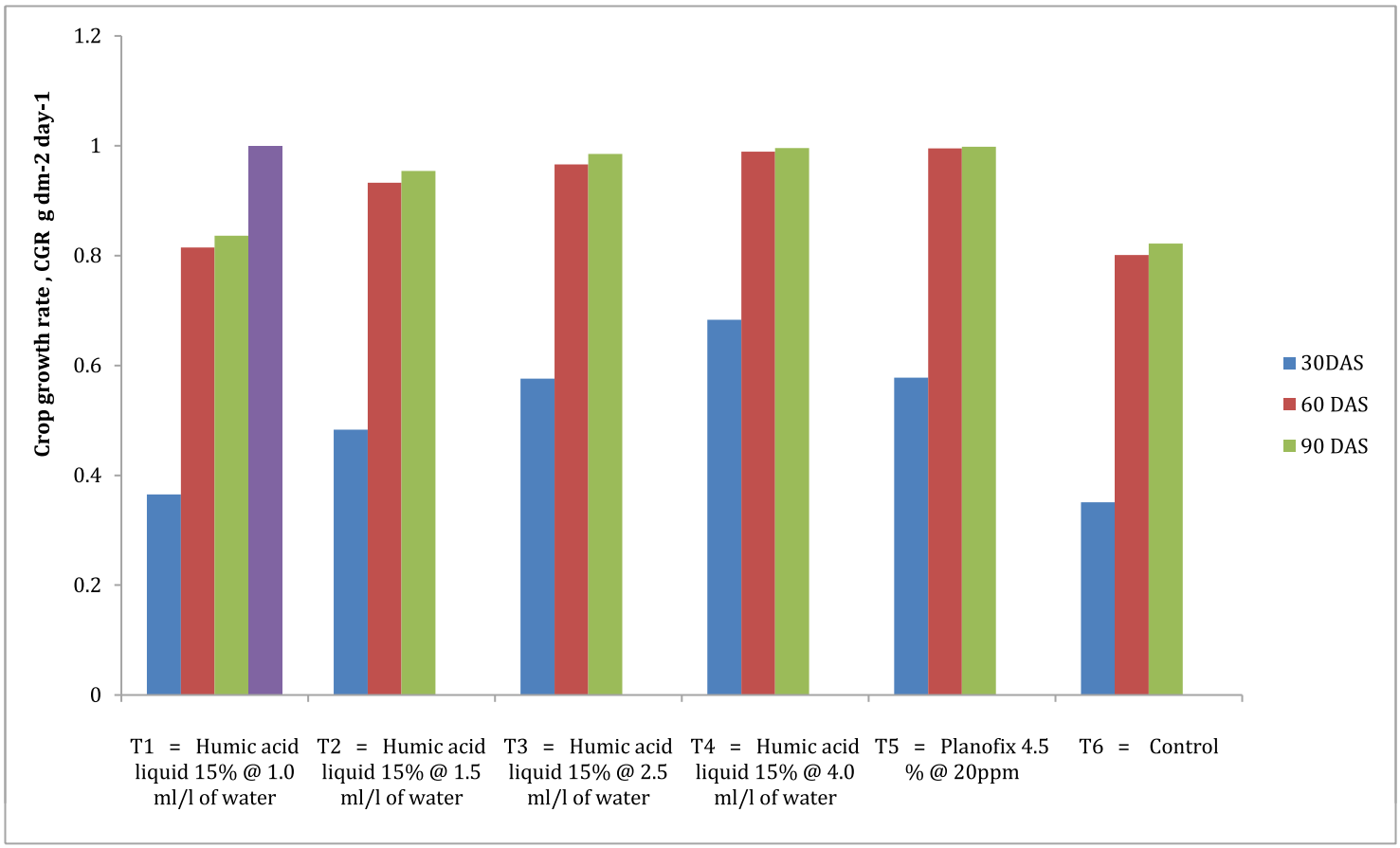

Fig. 6 Influence of foliar application of Humic acid on crop growth rate (CGR , g dm-2 day-1) at different stages of crop growth in Redgram

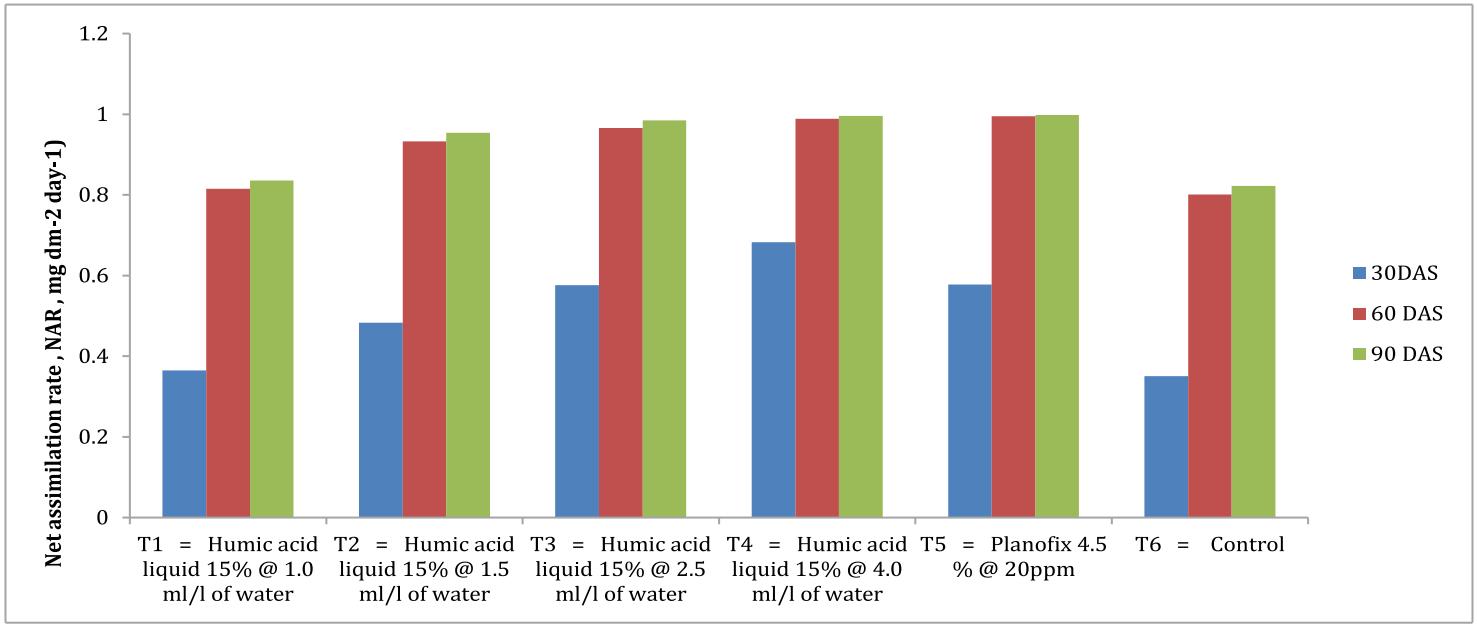

Fig. 7 Influence of foliar application of Humic acid on net assimilation rate (NAR , mg dm-2 day-1) at different stages of crop growth in Redgram

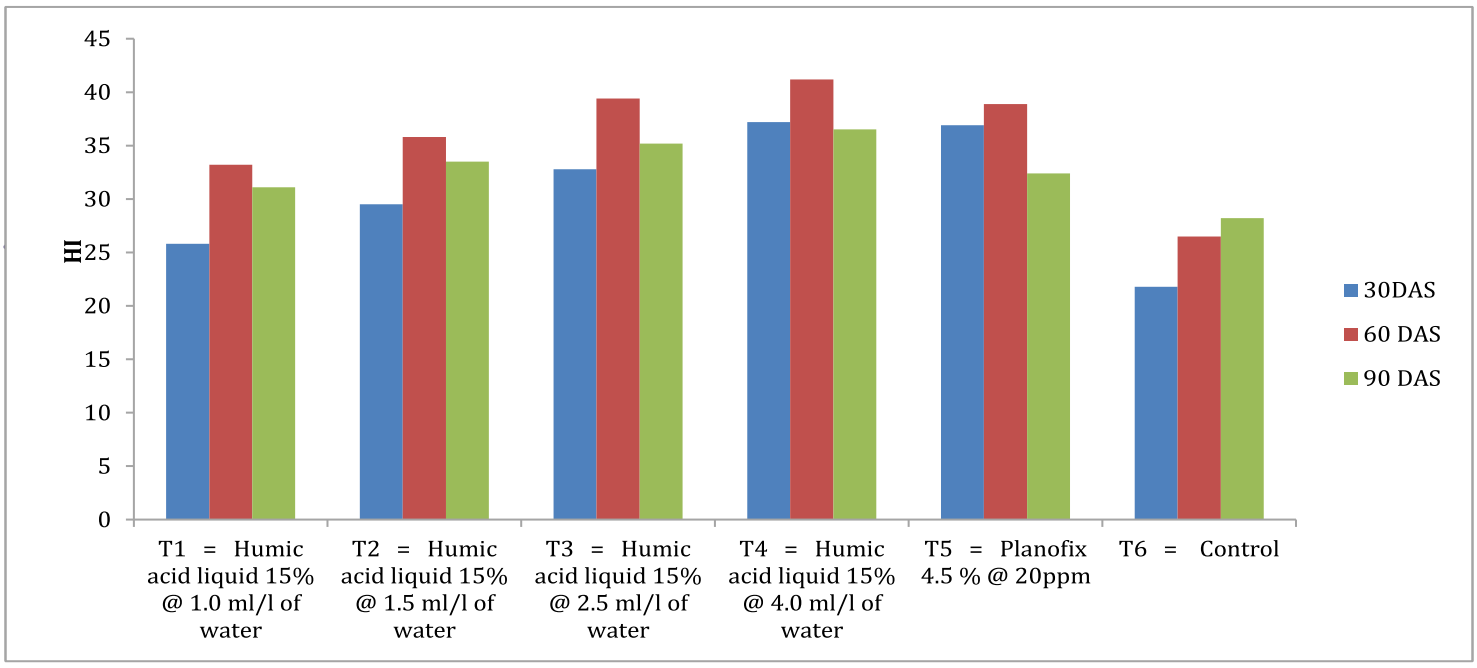

Fig. 8 Influence of foliar application of Humic acid on Harvest Index (HI) at different stages of crop growth in Redgram

CONCLUSIONS

Application of humic acid substances at the start of the growing season induced an overall positive effect on the growth, development and dry matter yield of red gram in the field.. The application of Humic acid Liquid 15% @ 4.0ml/L at the flower bud formation stage may reduce flower drops in red gram compared to the control. It was also observed that the foliar application of all the doses of Humic acid Liquid 15% on program 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. An increment in Humic acid concentration increased the 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 levels of Humic acid while comparing it with other manures and organic fertilizer sources.

Future scope of study

The strategies for future research and development to improve the efficiency and acceptability of foliar application of humic acid in agriculture are outlined below; Intensive research is needed to determine the duration up to which the humic acid remains active in the plant system and its metabolism. Response of crops to humic acid under different a biotic stress conditions may be evaluated for their efficient utilization in agricultural and horticultural crops. Systematic study on source-sink relationship may be done along with the foliar application of humic acid in all pulse crops.

Declaration of conflicting interests

The author(s) declared that there is no conflicts of interest with respect to the research, authorship, and/or publication of this article.

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REFERENCE

1. Abdel Mawgoud A, El. Greadly M.R.N, Helmy Y.I. and Singer S.M. 2007. Responses of tomato plants to different rates of humic based fertilizer and NPK fertilization. Journal of Applied Sciences Research 3, 169-174.

2. Anonymous., 2014, All India area, production and yield of pigeonpea. Agricultural Statistics at Glance., 106-107

3. Albayrak S and Camas N. 2005. Effects of different Levels and Application Times of humic acid on root and Leaf Yield and Yield components of forage turnip (Brassica rapa L.),Journal of Agronomy 42, 130-133.

4. Ayuso M, Hernandez T and Gercia C. 1996. Effect of humic fraction from arban wastes and other more developed organic materials on seed germination. Journal of science of food end agriculture 72, 461- 468.

5. Azizi M. 1998. The effect of different irrigation regimes and potassium fertilizer on agronomic, physiological, and biochemical properties of soybean.PhD Thesis in Agriculture, Mashad University, 143 p.

6. Donald, C.M., 1962. In search of yield. 1. Aust. Inst. Agric. Sci., 238, 171-178.

7. Daur I and Bakhashwain A. 2013. Effect of humic acid on growth and quality of maize fodder production.Pakistan Journal of Botany 45, 21-25.

8. El hendi M, Bd elaal H.A. and Shaimaa O. 2011. Effect of npk and humic acid applications on growth of egyptian cotton. Journal Plant production, mansoura university 3, 2287-2299.

9. Ghorbani S, Khazaei HR, Kafi M and BanayanAval M. 2010. The effect of adding humic acid to irrigation water on yield and yield components of corn. Journal of Agriculture ecology 2, 123-131.

10. Haghighi S, Saki nejad T and Lack S.H. 2013. Life science journal, 8, Evalution of changes the qualitation & quantitative yield of horse been (vicia fabal)plant in the levels of humic Acid fertilizer.

11. Kouchaki A, Banayan and Aval M. 2007. Legumes Farming, Jihad Daneshgahi Publications, Mashad, 67-79 p.

12. Majedi M.R. and Khademi Z. 2006. Effects of potassium and phosphorus placement for corn crops. Balanced use of fertilizers and plant response to K International Conference. Institute of Soil and Water Research. Institute International, potassium, Tehran,Iran

13. Sabzevari S.H. and Khazaei R. 2009. The effect of foliar spray of different levels of humic acid on growth characteristics and yield of wheat, Pishtaz cultivar. Journal of Agricultural Ecology 1, 53-63.

14. Sharifi M, Khattak R.A. and Sarir M.S.. (2002). Effect of different levels of lignitic coal dervedhumic acid on growth of surface-irrigated wheat. Agricultural science 52, 207-210.

15. Turkmen O, Dursun A and Turan M. 2004. Calcium and humic acid affect seed germination, growth, and nutrient content of tomato (Lycopersicon esculentum L.) seedlings under saline soil conditions. Soil and plant science 54, 168-174.

16. Gregory, F. G. 1926, The effect of climatic conditions on the growth of barley. Annals of Botany, 40: 1-26.

17. Radford, P. J., 1967, Growth analysis formulae – their use and abuse, Crop Science, 7: 171-175.

18. Stickler, F. C., Wearden ,S. Pauli, A. W. 1961 Leaf area determination in grain sorghum. Agron.J., 53:187-188

19. Sestak, Z., Catsky, J. and Jarvis, P. G., 1971, Plant photosynthetic production, Manual of Methods, Ed. Junk, W.N.V. Publications, The Hungus, pp. 343-381

20. Power, J. F., Willis, W. O., Gunes, D. L. and Peichman, G. A., 1967, Effect of soiltemperature, phosphorus and plant age on growth analysis of barley. AgronomyJournal, 59: 231-234.

21. Panse, V.C. and Sukhatme, P.V., 1967, Statistical method for Agricultural workers, Indian Council Agriculture Research, New Delhi, pp. 167-174.

22. Sharif M, Khattak R. and Sarir M. 2002. Effect of different levels of lignitic coal derived humic acid on growth of maize plants.Communications in Soil Science and Plant Analysis. 33 : 3567–3580.

23. Tahir M M, Khurshid M, Khan M Z, Abbasi M K and Kazmi M H.2011. Lignite-derived humic acid effect ongrowth of wheat plants in different soils. Pedosphere. 21 (1) : 124-131.

24. Watson, D. J., 1956, Leaf growth in relation to crop yield. Ed. F.L. Milthorpe, Butterworths Scientific Publications London pp. 178-191

25. Xiumei L and Yaping L. 2003. An experiment on the best application amount of K2 SO4 for potato (Solanumtuberosum) grown in chernozem soil. Chinese Potato Journal 17, 23-24.

26. Ziyaeyan A.H.. 2004. Effect of potassium application on forage maize in the agriculture, Journal of Soil and Water Sciences, Volume 20. No. 1.