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Influence of Aminoacids Micronutrients and Growth Promoting Substances on Growth and Yield of Black Gram [*Vigna mungo* (L) Hepper]

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A B S T R A C T

A study was carried out at S. V. Agricultural College, Tirupati to know the effect of foliar application of amino acids, micronutrients and growth promoting substances on growth parameters and yield of blackgram. It was observed that spraying of aminoacid (arginine and glutamine @ 1000 ppm) increased crop growth rate, relative growth rate, net assimilation rate, specific leaf area, specific leaf weight, total dry matter, seed yield and harvest index when compared to other treatments and control. However two percent urea application also recorded on par values. Incompatibility was observed among some of the chemicals used in this experiment. This incompatibility reflected negatively on growth parameters and yield.

Introduction

Blackgram (*Vigna mungo* L.) is one of the major rainy season pulse crops grown throughout India. It is cultivated in about 3.2 m ha in India with 1.9 m tonnes of production and 604 kg ha^{-1} productivity in 2014-15 (www.Indiastat.com). In Andhra Pradesh its area of cultivation is about 0.31 m ha with 0.29 m tonnes of production and 946 kg ha^{-1} of productivity during 2014-15 (www.Indiastat.com).

The yield potential of blackgram is general and pulse crops as a whole is very low because of several management related and crop related reasons. Blackgram is generally grown in rainfed conditions with poor management practices. Apart from the genetic makeup, the physiological factors *viz.*, insufficient partitioning of assimilates, poor pod setting due to the flower abscission and lack of nutrients during critical stages of crop growth, coupled with a number of diseases and pests (Mahala *et al.*, 2001) were explained as the reasons for poor yield.

The productivity of pulse crops in our country, including blackgram is not sufficient enough to meet the domestic demand of the population. Hence, there is need for enhancement of the productivity of blackgram by proper agronomic practices. Several strategies have been initiated to boost the productivity of blackgram. One among them is foliar application of organic and inorganic sources of nutrients for exploiting genetic potential of the crop. This is considered to be an efficient and economic method of supplementing part of the nutrient requirements at critical stages. Nutrients play a pivotal role in increasing the seed yield in pulses (Chandrasekhar and Bangarusamy, 2003).

Foliar application is credited with the advantage of quick and efficient utilization of nutrients, elimination of losses through leaching and fixation and regulating the uptake of nutrient by plants (Manonmani and Srimathi, 2009).

Black gram is indeterminate in its flowering and fruiting habits and there is a competition for available assimilates between vegetative and reproductive sinks. There is a limitation of source (leaves) particularly at flowering and fruiting stage. Hence, it is necessary to improve LAI and LAD. As, the source is highly limited in pulses with lowering translocation of assimilates to the growing reproductive sinks. Hence, leaf area is an important parameter to obtain higher source in terms of higher assimilate production. Being a C_3 plant, CGR and RGR are relatively less than cereals. Apart from this genetic makeup, the major physiological constraints limiting its production are flower drop and fruit drop (Ojeaga and Ojehomon, 1972).

Amino acids are the building blocks of proteins and serve in a variety of important path ways. They are important in many biological molecules, such as forming part of coenzymes, or as precursors for biosynthesis of molecules such as glutamine (Glu) and ornithine, which serve as precursors for nucleotides and polyamines respectively (Alcazar *et al.,* 2010). When applied together with amino acids the absorption and transportation of micronutrients inside the plant was easier (Ibrahim *et al.,* 2010).

Deficiency of micronutrients during the last three decades has grown in both magnitude and extent because of increased use of high analysis fertilizers, use of high yielding crop varieties and increased cropping intensity. This has become a major constraint to production and productivity of rice, wheat and pulses.

Further, plant hormones are related to play an important role in manipulation of source sink relationship in pulse crops. Auxins help in retention of flowers and pods and facilitate increased sink demand. Cytokinins promote extended period of green leaf retention and thus help to attain increased source capacity.

Plant hormones in a broad sense are organic compounds which play an important role in plant growth development and yield of crops to prevent the fruit and flower drop for a longer period. Application of growth promoting hormones is a recent technique in this direction.

The growth promoting or regulating chemicals like amino acids, plant hormones and micronutrients manipulate source sink relationship through increased capacity of source and increased translocation of assimilates to sink. Foliar application of growth regulating or growth promoting chemicals at the critical growth stages of the crop to improve their performance is one of potential options. During the last decade, foliar application of nutrients has become an established method in crop production to increase yield and to improve the quality (Khalilzedeh, 2012). Nutritional spraying on plants decrease the delay between absorption and consumption of elements by plants, which is very important for accelerating the plant growth.

Thus, the objective of the present study was to know the effect of foliar applied amino acids, growth promoting substances, micronutrients and urea on various physiological and yield parameters of blackgram.

Materials and Methods

A field experiment was conducted during *rabi* season of 2014-15 at S.V. Agricultural College Farm, Tirupati.The experiment was laid out in randomized block design with 17 treatments replicated thrice. Where in T_1 was Glutamine + Arginine; T_2 Glutamine; T_3 Arginine ;T_4 Ammonium molybdate + Borax; T_5 Ammonium molybdate; T_6 Borox; T_7 NAA + BAP; T_8 NAA; T_9 BAP; T_{10} Ammonium molybdate + Borox + NAA + BAP; T_{11} Borox+ NAA + BAP; T_{12} Ammonium molybdate + NAA + BAP;T_{13} Glutamine + Arginine + Ammonium molybdate + Borox + NAA + BAP; T_{14} Arginine + Ammonium molybdate + Borox+ NAA + BAP; T_{15} Glutamine + Ammonium molybdate +Boron + NAA + BAP;T_{16} Control *i.e.* water spray and T_{17} was Urea spray.

The concentration of the chemicals was fixed irrespective of its application either alone or in combination. The concentrations used in the experiment were - Glutamine @1000 ppm, Arginine @1000 ppm, Ammonium molybdate @ 0.3 %, Borax @ 0.5 %, NAA @ 100 ppm and BAP @ 50 ppm. Concentration of different spray solutions were decided based on literature search. In the control treatment 100 % recommended dose of fertilizers were supplied as basal dose and in the rest of the treatments fertilizers were applied @ 75% RDF. The experiment was conducted in a sandy clay loam soil with a plot size of 2x6 mt following standard package of practices. The spacing adopted was 30x10 cm. Black gram variety PU-31 was selected for the study. Three irrigations were given to the crop *i.e*., at sowing, 20 DAS and at flowering stage.

Foliar application of growth promoters (NAA and BAP), micronutrients (borax and ammonium molybdate) and amino acids (argnine and glutamine) described in experimental details was done at vegetative stage, flowering stage and pod formation stage *i.e.* 20 DAS, 40 DAS and 60 DAS respectively. Morphological, physiological and yield observations were recorded 15 days interval. Destructive sampling of 5 plants from each replication was done.

The experimental data were analyzed by the method of analysis of variance following RBD as per the procedure outlined by Panse and Sukhtame (1985). Significance was tested by comparing F-value at 5 % level of probability wherever F- test was significant.

Results and Discussion

Growth parameters

Crop growth rate (g m^2 d^{-1})

Irrespective of the treatments imposed crop growth rate was increased from 15-30 DAS to 45-60 DAS and thereafter decreased at 60-75 DAS. CGR was at its peak between 30-60 DAS. A significant difference in CGR at all the crop growth stages were observed among the treatments imposed (Table 1).

At 30-45 DAS T_1 recorded, significantly higher CGR (5.71), followed by T_2 (5.43), T_{17} (5.24) and T_3 (5.05) compared to control (4.43). Whereas T_{15} (0.05) recorded lowest CGR (Fig. 2).

Surendar *et al.,* (2013) also found that the basal application of nitrogen 25kg ha^{-1} with foliar spray of urea 2per cent and 0.1 ppm brassinolide significantly expressed the higher values in growth attributes *viz*., Leaf area index, Crop growth rate, Net assimilation rate and Specific leaf weight

Relative growth rate (g g^{-1} d^{-1})

The results indicated that irrespective of the treatments imposed RGR increased from 15-30 DAS to 30-45 DAS and decreased further at 45-60 DAS and 60-75 DAS.

RGR was found to be at its peak at 30-45 DAS significant difference among various treatments with respect to RGR at all the crop growth stages was observed.

At 15-30 DAS T_2 (0.17) recorded significantly higher RGR followed by T_1 (0.16), T_3 (0.15), and T_7 (0.15), compared to control (0.001). Significantly lowest RGR was recorded by T_{14} (0.125).

Ramesh and Ramprasad (2013) reported similar results in LAI, CGR and RGR with the application of NAA (20 ppm) and brassinosteroid (25 ppm) in Soybean.

Net assimilation rate (mg cm^{-2} d^{-1})

The results indicated a steady decrease in NAR from 15-30 DAS to 60-75 DAS.

A significant difference among various treatments was observed almost at all the crop growth stages except at 15-30 DAS.

At 30-45 DAS T_{17} recorded significantly, highest NAR (0.00123) whereas T_{14} recorded significantly lowest NAR (0.00003) compared to control (Fig. 1).

However, T_2 (0.00117), T_3 (0.00109), T_1 (0.00106), T_6 (0.00106) are observed to be at par with control (0.00109). A similar trend was observed at 45-60 DAS and 60-75 DAS.

Specific leaf area (cm^2 g^{-1})

The data indicated that specific leaf area from 30 DAS to 45 DAS was decreased whereas from 45 to 60 DAS an increase in specific leaf area was observed.

Further at 60 to 75 DAS due to reduction in leaf area the specific leaf area was also decreased. However a significant difference among various treatments with respect to SLA was recorded.

Among different treatments SLA was found non-significant at 15 DAS. However at 30 DAS a significantly higher SLA was recorded in T_{15} (453.7) followed by T_{14} (392.8), T_{13} (364.1), T_{12} (318.2), T_{11} (295.9), T_{10} (293.0) and T_9 (273.9). This was due to very lesser increase in leaf area in these treatments. Further in those treatments where a lower SLA was recorded, showed corresponding higher leaf area values (T_1 (152.2), T_2 (171.84), T_3 (174.2).

Kalarani (1991) also observed that the foliar application of 1 per cent urea and 50 ppm NAA significantly influenced the specific leaf area in soybean

Specific leaf weight (g cm^{-2})

The data indicated an increase in specific leaf weight from 15 DAS to 75 DAS irrespective of the treatments imposed. At 15 DAS SLW among various treatments imposed was found to be non-significant.

However at 30 DAS T_1 recorded significantly higher SLW (0.00669) compared to that of control (0.00546). Whereas T_{14} showed a significantly lowest SLW (0.00251).

At 45 DAS T_{17} recorded a significantly highest SLW (0.00803) compared to control (0.00701).

Table.1 Effect of foliar application of amino acids, growth promoting substances, micronutrients and urea on crop growth rate (g m^{-2} day^{-1}) at different growth stages Blackgram

		Crop growth rate (g m^{-2} d^{-1})			
S.NO	**Treatments**	**15-30 DAS**	**30-45 DAS**	**45-60 DAS**	**60-75 DAS**
1	**Glutamine @ 1000 ppm+ Arginine @ 1000 ppm (T_1)**	0.167	5.71	5.85	4.46
2	**Glutamine @ 1000 ppm (T_2)**	0.176	5.43	5.33	4.59
3	**Arginine @ 1000 ppm (T_3)**	0.158	5.05	5.42	4.92
4	**Ammonium molybdate @ 0.3% + Borax @ 0.5 % (T_4)**	0.150	3.13	5.63	4.20
5	**Ammonium molybdate @ 0.3% (T_5)**	0.148	3.32	6.39	0.37
6	**Borax@ 0.5 % (T_6)**	0.141	3.74	5.66	2.22
7	**NAA @100 ppm + BAP @ 50 ppm (T_7)**	0.155	1.85	6.07	1.77
8	**NAA @100 ppm (T_8)**	0.137	1.41	6.13	1.66
9	**BAP @ 50 ppm (T_9)**	0.144	0.61	5.54	1.75
10	**Ammonium molybdate@ 0.3% + Borox @ 0.5 % + NAA @100 ppm + BAP @ 50 ppm (T_{10})**	0.134	0.25	5.28	0.56
11	**Borox@ 0.5 % + NAA @100 ppm+ BAP @ 50 ppm (T_{11})**	0.131	0.25	4.98	1.90
12	**Ammonium molybdate @ 0.3% + NAA @100 ppm + BAP @ 50 ppm (T_{12})**	0.132	0.15	3.86	0.42
13	**Glutamine @ 1000 ppm + Arginine @ 1000 ppm + Ammonium molybdate @ 0.3% + Borox @ 0.5% + NAA @ 100 ppm+ BAP @ 50 ppm (T_{13})**	0.138	0.11	2.99	1.820
14	**Arginine @ 1000 ppm + Ammonium molybdate @ 0.3% + Borox@ 0.5 % + NAA @100 ppm + BAP@ 50 ppm (T_{14})**	0.125	0.05	2.10	1.35
15	**Glutamine @1000 ppm + Ammonium molybdate @ 0.3%+Borax @ 0.5 % + NAA @100 ppm + BAP @ 50 ppm (T_{15})**	0.126	0.09	1.49	1.15
16	**Control (water spray) (T_{16})**	0.151	4.43	4.65	4.18
17	**Urea spray (2%) (T_{17})**	0.144	5.24	4.15	5.24
	Mean	**0.145**	**2.40**	**4.80**	**2.50**
	C.D	**0.020**	**0.46**	**1.25**	**0.55**
	SE (m)	**0.007**	**0.162**	**0.435**	**0.191**
	CV	**8.089**	**11.66**	**15.68**	**13.18**

Fig.1 Effect of foliar application of amino acids, growth promoting substances, micronutrients and urea on net assimilation rate (mg cm^{-2} day^{-1}) at different growth stages of Blackgram

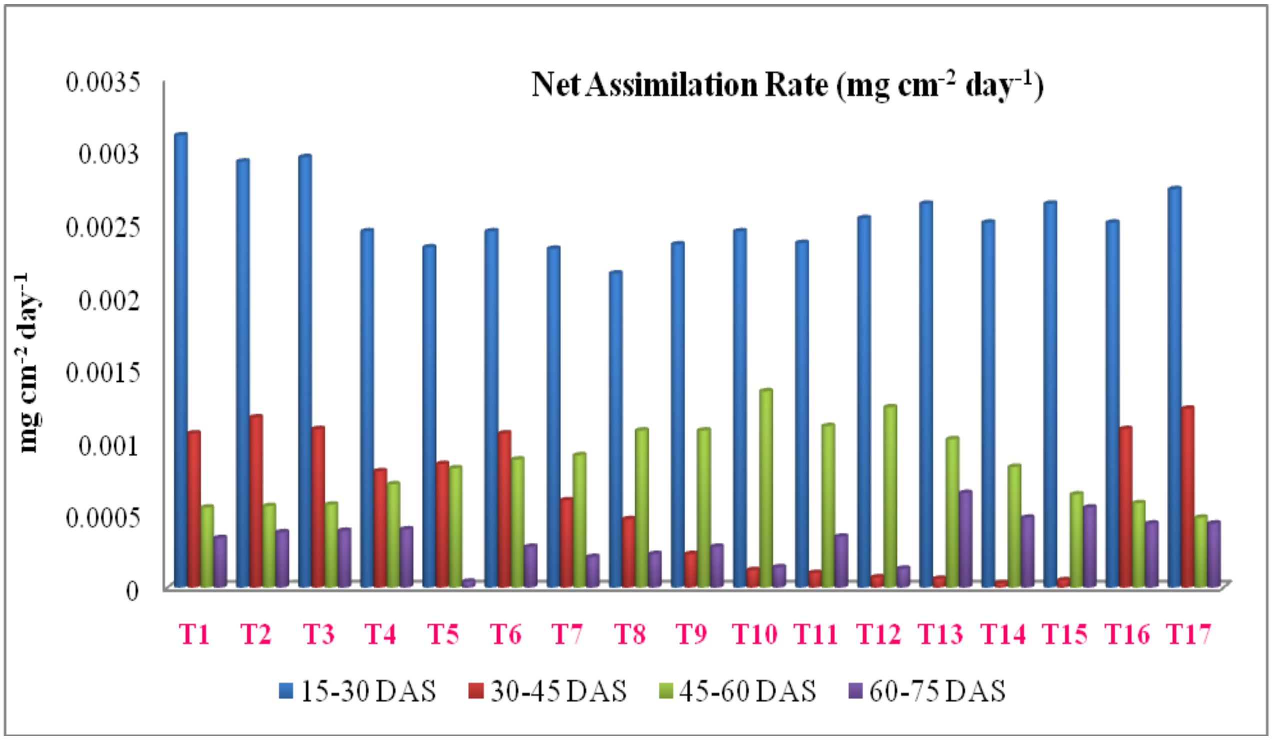


Fig.2 Effect of foliar application of amino acids, growth promoting substances, micronutrients and urea on net assimilation rate (mg cm^{-2} day^{-1}) at different growth stages of Blackgram

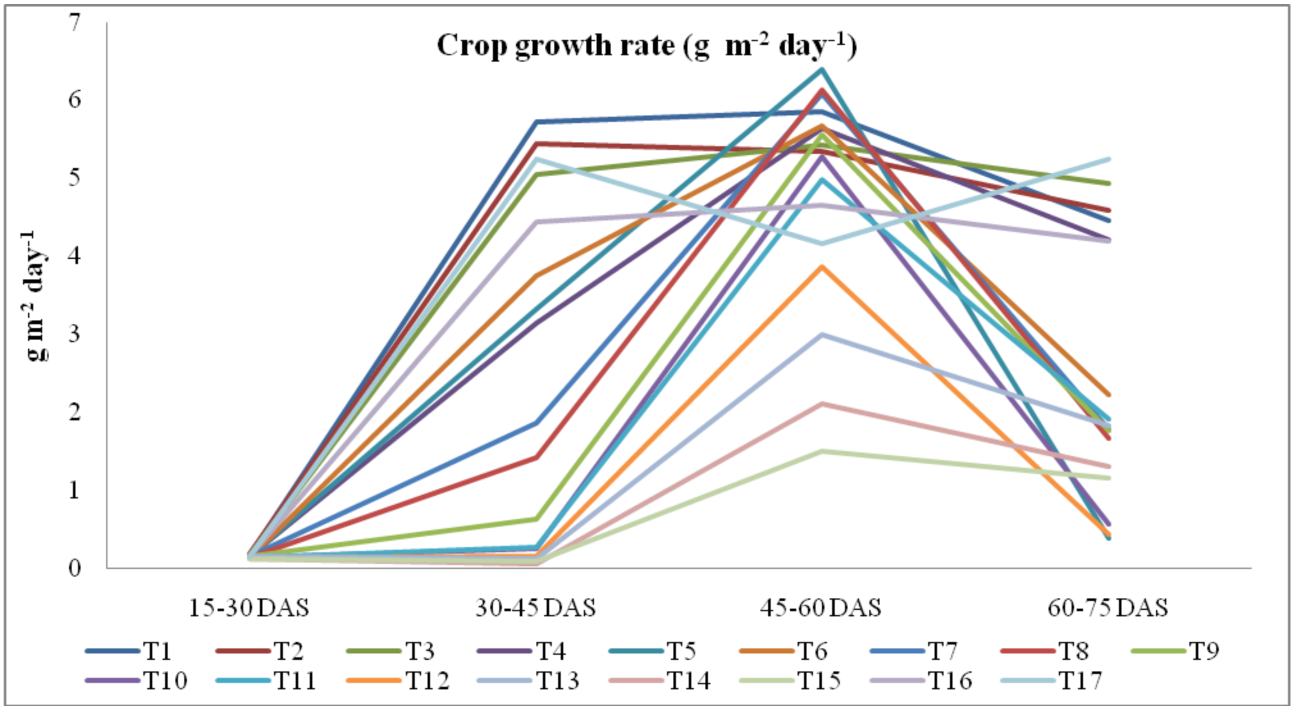
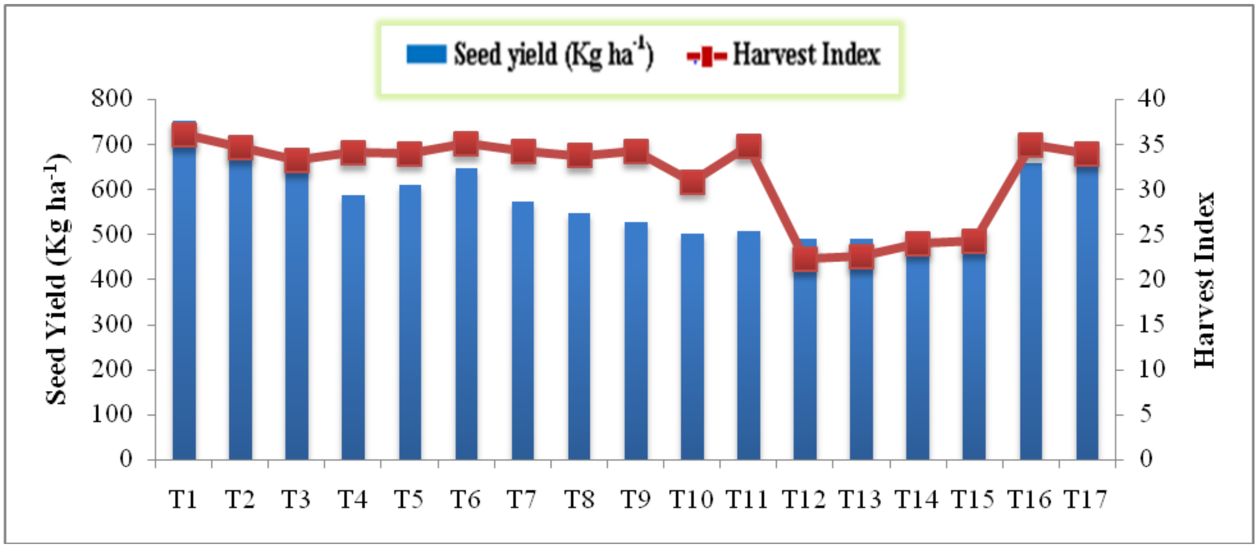


Fig.3 Effect of foliar application of amino acids, growth promoting substances, micronutrients and urea seed yield and harvest index at different growth stages of Blackgram



However, T_{15} was observed to have significantly lowest SLW (0.00162). Similar trend was also observed at 60 DAS and 75 DAS.

Specific leaf weight is a measure of leaf thickness, which was reported to have a strong positive correlation with leaf photosynthesis of several crops. Thicker leaves would have more number of mesophyll cells with high density of chlorophyll and, therefore, have a greater photosynthetic capacity than thinner leaves. SLW is highly correlated with the development of reproductive organs (Bindu Joseph, 2000 and Bowes *et al.*, 1972).

Total dry matter

Irrespective of the treatments imposed a continuous increase in total dry matter production was observed from 15 DAS to 75 DAS. No significant difference in total dry matter was observed at 15 DAS.

At 30 DAS T_1 recorded significantly higher total dry matter (2.50) followed by T_2 (2.23) and T_3 (2.21) compared to control (1.81). Significantly lowest total dry matter was produced in T_{15} (1.02) followed by T_{14} (1.19). However T_{17} (1.99), T_4 (1.78), T_5 (1.67), T_{16} (1.58) T_7 (1.51) and T_8 (1.44) were found to be at par with control. A similar trend was observed at 45, 60 and 75 DAS. During most of the crop growth period T_4 recorded total dry matter at par with control.

Yield parameters

Seed yield (Kg ha^{-1})

The highest seed yield was observed in T_1 (751.3), followed by T_2 (709.7), T_3 (697.1), T_{17} (672.5), T_6 (645.0), T_5 (610.5), T_4 (587.8), T_7 (572.2), T_8 (545.8), T_9 (526.1) T_{10} (501.9) and T_{11} (506.1). However they are at par with control (672.5). Significantly the lowest seed yield was recorded in T_{15} (467.2) followed by T_{14} (480.0), T_{12} (490.56) and T_{13} (490.2).

The result indicated that the seed yield did not differ significantly among the treatments *viz.*, amino acids (alone or in combination), micronutrients (alone or in combination) and growth promoting substances individually or in combination. However a significant decrease in seed yield was observed in those treatments where the antagonistic effect of foliar nutrition was observed (T_{15}, T_{14}, T_{12} and T_{13}) (Fig. 3).

Harvest index

The highest harvest index was recorded by T_1 (36.05), it was found at par with T_6 (35.01), T_{16} (control) (34.8), T_{11} (34.7), T_2 (34.6) T_9 (34.2), T_7 (34.1), T_4 (34.0), T_5 (33.9), T_{17} (33.8), T_8 (33.6), T_3 (33.2) and T_{10} (30.7).

However significantly lowest harvest index was recorded in T_{12} (22.2) compared to control (34.8) and was at par with T_{13} (22.4), T_{14} (23.9) and T_{15} (24.1).Harvest index in these treatments is reduced because of more reduction in seed yield than in dry matter production which resulted in less seed yield to total dry matter ratio i.e., H.I.

Jafar Ullah *et al.*, (2007) also reported an increase in harvest index (37.32 per cent) with application of 1250 ppm Knap (sea weed extract containing amino acids) and NAA in cowpea.

From the experiment it could be concluded that foliar application of amino acids, micronutrients and growth promoting substances increased the ability of the plant to grow in its initial stages. However some of the combinations of these substances (amino acids, micronutrients and growth promoting substances) showed incompatibility on the foliage. Hence it should be further tested to see the compatibility of these substances when they are incorporated in to any commercial formulation. Several commercial formulations in the market of late claiming the combinations of aminoacids, micronutrients and growth promoting substances. However in the present study incompatibility was seen among some of the compounds. Besides at par yield was seen with 2 percent urea foliar application compared to aminoacids and micronutrient application either alone or in combination

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