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Effect of various amino acid based growth substances on phenological and physiological Parameters of soybean (*Glycine max* (L.) Merrill)

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Abstract:

In present study field experiments were conducted at the Research Farm Adhartal, Department of Plant Breeding and Genetics, JNKVV, Jabalpur (M.P.) during *Kharif* season of 2015-2016. The research experiment was laid out in a Randomized block design with thirteen replications and two treatments i.e T1- control (untreated) and, T2-Treated amino acid complex T2-Treated amino acid complex @3ml/kg seed (seed coating with 5-7ml water) comprised of soybean genotype JS 97-52. Five plants were randomly selected from each treatment and replications for Phenological and Physiological Parameters. The phenological observation showed the impact of amino acid seed treatment on various phenophasic developments. Treated plants (37.00 days) took shortest time for flower initiation whereas control plants had the late appearance of flower initiation (46.92 days) in soybean plants. Treated plants (53.61 days) took shortest time for 50% flowering whereas control plants had the late appearance of 50% flowering (56.38 days) in plants. Control (50.92) took higher days to pod formation, whereas treated plants (48.92) took the minimum time to pod formation. Days to maturity was also varied significantly for soybean. Maximum and minimum value was recorded in control (97.77) and treated plants (92.75).Maximum photosynthetic rate was recorded in treated plants (18.37 µmol/m2/s) followed by control plants (17.74 µmol/m2/s), water use efficiency in treated soybean plants (24.54 µmol/mmol) was measured followed by control plants (23.54 µ mol/mmol), stomatal conductance was recorded higher in treated plants (0.749 mol/m2/s) followed by control plants (0.713 mol/m2/s). Transpiration rate was recorded lower in treated soybean (6.56mmol/m2/s) as against control (7.07mmol/m2/s) and relative water content was recorded maximum in treated plants (74.23%) followed by control soybean plants (70.31%).

Keywords: Growth substances, soybean, (*Glycine max* (L.) Merrill), amino acid , Phenological Parameters and Physiological Parameters

Introduction:

Soybean (Glycine max (L.) Merrill) is native of China. It has emerged as one of the important commercial crops in many countries. Soybean is also known as the “Golden bean” or “Miracle crop” because of its multiple uses. Soybean seed contains 18-20 per cent oil, 40 per cent protein, 30 per cent carbohydrates, 4 per cent saponins and 5 per cent fiber. The oil contains about 0.5-1.0 per cent lecithin which is essential for building up of

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human nerve tissues. Soybean is a crop of multiple qualities as it is both a pulse and oilseed crop. In India, It contributes around 25% of total edible oil pool of the country. The area planted with soybeans worldwide was 102.4 million hectares, with total production of 261.6 million tons in the same year (FAOSTAT, 2015).The main soybean producing states in India are Madhya Pradesh (56 percent), Maharashtra (37 percent), and Rajasthan (11 percent). All India soybean production is 86.426 Lakh MT and average yield is 784 kg/ha on 110.656 lac ha. Madhya Pradesh is known as the "Soybean State" of India, comprising 55% of the total national area of soybean cultivation. In Madhya Pradesh the area under soybean cultivation during Kharif 2015 was 59.062 lac ha and production was 86.426 lac MT and average yield was 781kg/ha during Kharif 2015 (SOPA 2015). Madhya Pradesh is the soybean bowl of India, contributing 65-70 per cent of country's soybean production, followed by Maharashtra, Rajasthan and Karnataka which is much below the average national and world productivity.

The productivity efficiency of any cultivar depends on its functional yield attributes which provide a basis for evolving better plant ideotype through breeding with higher yield potential and its maximum realization in a given set of environmental conditions. Higher seed yield of any crop can be achieved only through proper combinations of a cultivar, environment and agronomic practices.The basic component of living cells is proteins, with building block material, amino acids. Proteins are formed by sequence of amino acids.. The requirement of amino acids in essential quantities is well known as a means to increase yield and overall quality of crops. The application of amino acids for foliar use is based on its requirement by plants in general and at critical stages of growth in particular. Plants absorb amino acids through stomata and are proportionate to environment temperature. Foliar nutrition in the form of protein hydrolysate (known as amino acids liquid) as foliar spray provides readymade building blocks for protein synthesis. HYT D (Agrinos, Mumbai) is a liquid formulation contains chitin, chitosan, glucosamine and free L-Amino acids from natural source through 100% organic fermentation process. It is ideal for seed treatment, which will result in increased seed germination index, improved vigour of seedlings, strengthened crop"s root formation and cell structures. Presence of L-Amino acids in HYTD supplements the requirement of seed/plant and increased protein synthesis, drought alleviation and all other stresses. Keeping in view of the above facts the main objectives of this study were (i) To investigate the effect of amino acid based growth substances on Phenological and (ii) Physiological Parameters of soybean

Materials and Methods: The present study was conducted at the Research Farm Adhartal, Department of Plant Breeding and Genetics, JNKVV, Jabalpur (M.P.) during Kharif season of 2015-2016. The research experiment was laid out in a Randomized block design with thirteen replications and two treatments i.e T1- control (untreated) and, T2-Treated amino acid complex T2-Treated amino acid complex @3ml/kg seed (seed coating with 5-7ml water) comprised of soybean genotype JS 97-52. Five plants were randomly selected from each treatment and replications for Phenological and Physiological

Parameters

1. Phenological Parameters :

(a) Days to flower initiation: A day to flower initiation was taken from the date of sowing to date of first flower seen in the field plants before 50% flowering.

(b) Days to 50% flowering: Days to 50% flowering was taken from the date of sowing to the date of 50% plants have at least one flower.

(c) Days to pod formation: A day to pod formation was taken from the date of sowing to the first pod visible on plant.

(d) Days to physiological maturity: This was recorded from the date of sowing to physiological maturity.

(e) Days to maturity: Days to maturity was taken from the date of sowing to the date when 95% pods turn yellow or brown.

2 Physiological growth parameters:

(a) Photosynthesis rate (µ mol/m2/sec):Net photosynthetic rate and PAR absorption was

observed with the help of Infra Red Gas Analyser (IRGA model LI-6400).

(b) Stomatal conductance (m mol/m2/sec):Stomatal conductance was recorded with the help of Infra Red Gas Analyser (IRGA model LI-6400)

(c) Transpiration rate (m mol/m2/sec):Transpiration rate was measured with the help of Infra Red Gas Analyser (IRGA model LI-6400).

(d)Water Use Efficiency (WUE): The water se efficiency was determined as per method given as follows:

(e)Relative Water Content (RWC %) : RWC (%) was calculated by the formula given below:

Where, Fw is fresh weight, Dw is dry weight and Tw is turgid weight of the leaf samples (4-mm diameter leaf discs). The turgid weight was determined after floating the leaf discs on distilled water for 24 h at room temperature (about 20°C) under dim light, whereas, dry weight was measured after oven-drying the samples at 80°C for 48 h.

Statistical analysis: Analysis of observations was taken on different variables was carried out to know the degree of variation among all the treatments. The pooled data was statistically analyzed using Analysis of variance (ANOVA) through randomized block design (Fisher, 1967).

Results and Discussion:

1. Phenological Parameters: The phenological stages showed significant variation with respect to various phenophases studied under control and treated condition (Table No.01)

(a) Days to flower initiation: A day to flower initiation was taken from the date of sowing to date of first flower seen in the field plants before 50% flowering. It is revealed from the data that the significant difference was noted for flower initiation. The minimum days for flower initiation were recorded (37.00) in seed treatment with amino acid complex @3ml/kg of seed in soybean as compared to control (46.92). The requirement of days to flower initiation plays an important role in the productivity of crops and was found to be positively correlated with seed yield (Adhikari and Pandey, 1982).The results showed that applying amino acids improved all growth and flowering characteristics of tuberose cultivars. Concentration of 0.75 mg L-1 amino acids enhanced the floral stem, inflorescence, and stem diameters. The fresh weight of floral stem increased about 22% as a result of spraying with 0.25 mg L-1 amino acid mixture. (Zahra et al. 2015)

(b) Days to 50% flowering: Days to 50% flowering was taken from the date of sowing to the date of 50% plants have at least one flower. Significant differences were exhibited for the days to 50% flowering. The minimum days for 50% flowering were registered under treated soybean (53.61) as against control (56.38). The longer duration of reproductive phase was found to be related with the higher economic productivity. Under full sun light condition (open field) with applying amino acid tryptophan at the different concentrations (0.0, 50,100,150 ppm) during the growing season, improved vegetative growth and flowering, number of leaves / plant at flowering time, number of days to flowering, number of flowering stalk / plant, flower stalk length, flower stalk diameter, number of florets / flower stalk, bulbs diameter (Aly et al. 2009)

(c) Days to pod formation: A day to pod formation was taken from the date of sowing to the first pod visible on plant. Treated plants (48.15) exhibited the significant earlier pod formation whereas control plants (50.92) noted maximum days to pod formation. The effect of amino acid foliar spraying on all measured traits was significant at 1% probability level. Also, the interaction effect of nitrogen and amino acid application on number of pods per plant at 5% was significant (Maral et al. (2012). However, results clearly indicated for the yield and yield components i.e., number of pods/plant, pod weight (g) and number of seeds per pod (Zewail et al. 2014).

(d) Days to physiological maturity: This was recorded from the date of sowing to physiological maturity. Results indicated that the treated plants (84.00) had significantly minimum span to attain physiological maturity. However, maximum days to attain physiological maturity (86.79) in control plants. The physiological maturity is regarded as a

reference point for determining the end of seed development .Comparison of the interaction of amino acids and variety on the number of days and degree of growth days showed that reducing the consumption of fertilizer, the duration of phenological period and the degree of growth of emergence of pollen and peak have increased. With increasing the joint consumption of amino acids, complete inoculation period, dought and physiological maturity have increased (Abbas et al. 2012).

(e) Days to maturity: Days to maturity was taken from the date of sowing to the date when 95% pods turn yellow or brown. It is revealed from the data that the treated plants had significantly lower span to attain field maturity (92.75) whereas, the maximum days to maturity (97.77) in control plants.

The timing of crop maturity is largely determined by the capacity of the plant to continue the production of new fruiting sites. Dry matter production could impinge both on the timing of crop maturity and yield (Bange and Milroy, 2004). Seed yield plant-1 was found to be significantly and positively correlated with days of maturity (Kumar et al. 2014). Among morphological traits under water stress conditions, the days to maturity showed the maximum reduction in soybean (94%) (Shadakshari et al. 2014).

2. Phenological Parameters: The effect of various amino acid based growth substances on Phenological Parameters of soybean is presented in the Table 02.

(a)Photosynthetic rate (µmol/m2/s) :The maximum value of photosynthetic rate was recorded under treated plants (18.37) whereas, the minimum value of photosynthetic rate was observed in control plants (17.74) . The positive correlation between photosynthetic rates and nitrogen contents in leaves. A high rate of photosynthesis due to a high nitrogen supply results in a higher biomass production (Neuberg et al. 2010). Increase in chlorophyll contents might be due to the availability of higher levels of amino acids to the treated plants as amino acids help to increase the chlorophyll content and this may lead to the increase in different growth criteria (Abo Sedera et al. 2010). Zewail et al. (2014) obtained that increase of photosynthetic pigments and total chlorophyll with increasing amino acid sprayed levels at the age of 65 days after sowing

(b) Stomatal conductance (mol/m2/s): The amino acid treatments significantly affected the stomatal conductance; maximum stomatal conductance was noted in treated plants (0.749). Minimum stomatal conductance was noted in control plants (0.713) in soybean. The reduction in transpiration rate and stomatal conductance and concomitant increase in intercellular CO2 concentration suggests that both stomatal factors were involved in the reduction of photosynthesis (Zhao et al. 2003). Foliar application of amino acid, at suitable concentrations, had positive effects on the content of secondary metabolites, antioxidants and antioxidant activity (Zahra et al. 2015).

(c) Transpiration rate (m mol/m2/s) : The significant differences were observed for transpiration rate. Under control plants was noted higher transpiration rate (7.07).Minimum was recorded in treated plants (6.56) in soybean variety JS-97-52. The transpiration is one of the major gas exchange parameters associated with plant growth and productivity (Taiz and Zeiger, 2002). The rate of transpiration decreased with the advancement of maturity. Also the positive effects of amino acids application may be brought about by its cell internal function as osmoregulatory (Taffouo et al. 2009).

(d)Water use efficiency (□mol/m mol):It is revealed from the data that the significant variation was existed in soybean for water use efficiency. The maximum water use efficiency was noted at pod filling stage in amino acid treated plants (24.68).Whereas, minimum was recorded in control plants (23.35). All studied characters of growth yield and its attributes and grain quality were negatively affected by lower water supplies, meanwhile a significant increase was obtained by the application of amino acid in leaf water deficit (Salwa et al. 2014).

(e) Relative water content (%) :Treated plants recorded the maximum relative water content at

pod filling stage (74.23). Minimum was observed in control plants in soybean variety JS-97-52 (70.31) . Water logging significantly reduced the relative water content (RWC) and membrane stability particularly in sensitive mungbean genotypes (Pramod Kumar et al. 2013). Salwa et al. (2014) revealed that characters of growth, relative water content (RWC), yield and its attributes and grain quality were negatively affected by lower water supplies, meanwhile a significant increase was obtained by the application of amino acid in leaf water deficit.

Knowing how plants function in a natural environment, their potential for harvest and how they might respond to potentially stressed environmental change is essential to learning how to manage world resources in a time of burgeoning world population. The physiology of photosynthesis – light capture, energy conversion and partitioning of carbon are at the root of productivity. The term productivity refers to an increase in biomass –

he dry matter content of an organ, organism or population.Carbon economy is the term used to describe balance between carbon acquisition and its utilization. Respiration is the principle counter balance to photosynthesis, respiration consumes assimilated carbon in order to obtain the energy required to increase and maintain biomass. Respiratory losses of carbon constitute one of the most significant intrinsic limitations on plant productivity.

Table 1: Effect of seed treatment with amino acid on Phenological stages of soybean

Replication	**Days to flower initiation**		**Days to 50% flowering**		**Days to pod formation**		**Days to physiological maturity**		**Days to maturity**	
	Control	**Treated**	**Control**	**Treated**	**Control**	**Treated**	**Control**	**Treated**	**Control**	**Treated**
1	44.80	35.50	56.00	54.00	50.00	44.00	90.33	89.00	99.33	97.67
2	45.20	35.60	58.00	56.00	55.00	53.00	87.67	82.33	99.33	94.33
3	44.30	34.90	60.00	53.00	51.00	50.00	84.00	83.33	97.67	93.33
4	46.00	36.00	55.00	52.00	51.00	51.00	85.00	85.00	95.00	94.00
5	46.50	36.50	56.00	54.00	58.00	57.00	90.00	85.67	100.00	96.00
6	47.60	37.70	57.00	55.00	47.00	43.00	83.00	80.33	91.00	87.00
7	47.00	37.00	55.00	51.00	53.00	47.00	88.90	85.60	100.00	93.00
8	48.40	38.30	57.00	55.00	53.00	48.00	85.33	85.33	96.67	93.67
9	47.90	38.80	53.00	50.00	47.00	46.00	88.80	85.30	97.33	96.67
10	48.80	38.00	55.00	52.00	50.00	48.00	87.33	75.33	101.00	94.00
11	49.00	38.10	58.00	55.00	50.00	48.00	82.30	80.00	96.00	81.00
12	47.00	37.00	58.00	56.00	47.00	46.00	87.67	86.67	98.00	93.33
13	47.50	37.60	55.00	54.00	50.00	48.00	88.00	89.67	99.67	96.67
Mean	**46.92**	**37.00**	**56.38**	**53.61**	**50.92**	**48.15**	**86.79**	**84.00**	**97.77**	**92.75**
SEM±	0.78		0.32		0.43		0.64		0.78	
CD 5%	2.41		0.98		1.34		1.97		2.40	

Table 2: Effect of seed treatment with amino acid on physiological parameters in soybean at pod filling stage.

Replication	Photosynthetic rate (□mol/m2/s)		Stomatal conductance (mol/m2/s)		Transpiration rate (mmol/m2/s)		Water use efficiency (□mol/m mol)		Relative water content (%)	
	Control	**Treated**	**Control**	**Treated**	**Control**	**Treated**	**Control**	**Treated**	**Control**	**Treated**
1	16.81	18.41	0.778	0.782	6.58	6.52	21.50	23.66	57.89	57.69
2	22.94	23.56	0.883	0.901	7.00	6.56	25.46	26.68	71.46	74.45
3	20.26	21.00	0.861	0.887	6.72	6.35	22.45	22.84	68.49	71.15
4	16.86	17.58	0.718	0.737	5.93	5.60	23.54	24.48	79.25	82.85
5	24.17	24.34	0.952	0.968	6.83	6.09	25.14	25.39	85.00	89.63
6	10.69	11.22	0.461	0.506	7.80	6.96	21.23	23.56	66.91	75.72
7	15.37	16.03	0.583	0.631	8.59	7.23	22.35	23.56	76.30	78.66
8	14.95	15.04	0.546	0.589	7.73	7.49	25.62	27.38	65.20	72.58
9	13.16	13.81	0.577	0.478	6.81	6.44	22.77	28.95	77.64	77.86
10	14.30	15.55	0.523	0.610	8.81	8.17	20.31	21.20	68.30	78.60
11	17.95	18.41	0.770	0.778	6.08	6.08	23.66	23.31	57.69	60.12
12	23.47	23.56	0.883	0.889	7.00	6.07	26.68	26.40	73.04	74.45
13	19.72	20.26	0.844	0.887	6.06	5.72	22.84	23.36	67.09	71.15
Mean	**17.74**	**18.37**	**0.713**	**0.749**	**7.07**	**6.56**	**23.49**	**24.54**	**70.31**	**74.23**
SEM ±	0.10		0.01		0.08		0.37		0.69	
CD 5 %	0.29		0.02		0.25		1.15		2.13	

References:

1. Abbas M, Valida L, Ali-zade,Chogan R and Amiri E. 2012. Effect of nitrogen on the growth levels and development of maize hybrids in the condition of amino acids application. International Journal of Agriculture and Crop Sciences 4(14): 984-992.

2. Abo Sedera FA, Abd ElLatif AA, Bader LAA and Rezk SM. 2010. Effect of NPK mineral fertilizer levels and foliar application with humic and amino acids on yield and quality of strawberry Egypt. Journal of Application Science 25: 154169.

3. Adhikari G and Pandey MP. 1982. Components analysis of seed yield in chickpea. Crop Improve 9(1): 69-74.

4. Aly H. El-Naggar and Eman A. Swedan. 2009. Effect of light intensity and amino acid tryptophan on the growth and flowering of amaryllis (*hippeastrum vittatum,* herb.) Plants. Journal Of Agriculture & Environment Science Alex University Egypt 8(1).

5. Bange MP and Milroy SP. 2004. Growth and dry matter partitioning of diverse cotton genotypes. Field Crop Research 87(1): 73-87.

6. FAOSTAT. (2015). Production crops. Roma, Food And Agriculture Organization Of The United Nations.

7. Fisher, R.A. (1967). Biometrika SS: 445-457.

8. Kumar P, Dhillon SK and Sao A. 2014. Genetic analysis of sunflower genotypes under water stress environments. International Journal Of Farm Sciences 4(4): 26-35**.**

9. Maral M, Sirous B, Ebrahim A, Reza KD and Hamid Reza B. 2012. Effects of nitrogen fertilizer management and foliar spraying with amino acid on yield of cowpea (*Vigna unguiculata* L.). International Journal of Agriculture and Crop Sciences 4 (20): 1489-1491.

10. Neuberg M, Pavlikova D, Pavlik M, Balik J. 2010. The effect of different nitrogen nutrition on proline and asparagines content in plant. Plant Soil Environment 56(7): 305–311.

11. Pramod Kumar, Pal Madan, Joshi Rohit, Sairam RK. 2013. Yield, growth and physiological responses of mung bean [Vigna radiata (L.) Wilczek] genotypes to waterlogging at vegetative stage. Physiological Molecular Biology Plants (April–June) 19(2):209–220.

12. S.O.P.A. (2015). The Soybean Processors Association of India. E-mail: sopa@sopa.org Website : www.sopa.org

13. Salwa AR, Hammad A, Ali and Osama AM. 2014. Physiological and biochemical studies on drought tolerance of wheat plants by application of amino acids and yeast extract. Annals of Agricultural Science 59(1): 133–145.

14. Shadakshari TV, Kalaimagal T, Senthil N, Boranayaka MB, Kambegowda R and Rajesha G. 2014. Genetic diversity studies in soybean (*Glycine*

max (L.) Merrill) based on morphological characters. Asian Journal of Biological Science 6(1): 7-11.

15. Taffouo VD, Kouamou JK, Ngalangue LMT, Ndjeudji BAN. 2009. Effects of salinity stress on growth, ion partitioning and yield of some cowpea (*Vigna unguiculata* L. Walp.) cultivars. International Journal of Botany 5(2): 135143.

16. Taiz L and Zeiger E. 2002. Plant physiology (3rd ed.) sinauer associates. Ingress publishers, Massachusetts.

17. Zahra Afifipour and Morteza Khosh-Khui. 2015. Efficacy of spraying a mixture of amino acids on the physiological and morphological characteristics of tuberose (Polianthes tuberosa L.). International Journal of Horticultural Science and Technology 2(2) 199-204.

18. Zahra O, Ardebili A, Moghadam RL, Ardebili NO and Pashaie AR. 2015. The induced physiological changes by foliar application of amino acids in *Aloe vera* L. plants POJ 5(3): 279-284.

19. Zewail RMY. 2014. Effect of seaweed extract and amino acids on growth and productivity and some biocostituents of common bean (*Phaseolus Vulgaris* L) plants. Journal of Plant Production, Mansoura University 5(8): 1441 –-1453.

20. Zhao, D, Reddy KR, Kakani VG, Reddy J and Sullivan J. 2003. Growth and physiological response of cotton (Gossypium hirsutum L.) to elevated carbon dioxide and ultra violet-B radiation under controlled environment condition. Plant cell Environment 771-782.