I J T A
© Serials Publications
National Academy of Agricultural Science (NAAS)
Rating : 3.03

Effect of growth regulators on growth parameters, biochemical constituents and yield of Soybean (*Glycine max* L.) during changing scenario of climate under mid hill conditions of North Western Himalayas

R. G. Upadhyay[*], *P. S. Negi, S. K. Yadav and Anil Kala*

Abstract: *The pot experiment was conducted to see the effect of growth regulators on growth parameters , biochemical constituents and yield of Soybean during changing scenario of climate under mid hill conditions of North Western Himalayas during kharief season 2014.The pot experiment was laid out in Complete Randomized Design with three replication. The experimental variable consisted of ten treatments having one main crop of Soybean as control (T_1-control, T_2-NAA-10 ppm, T_3-NAA-20 ppm, T_4-NAA-30 ppm, T_5-2-4-D-10 ppm, T_6 – 2-4-D-20 ppm, T_7-2-4-D – 30 ppm, T_8- KNO_3-100ppm, T_9- KNO_3-200 ppm, T_{10}- KNO_3-300ppm. The pot soil in the ratio of 20:40:40 was fertilized with nutrients like N: P: K. The variety Harit Soya (*Glycine max L.) *was used in this experiment. The plant was sprayed with different concentrations of growth regulators about one week earlier to bud initiation. The second spraying was done at the stage of 50 percent flowering. The observations on progressive growth parameters like plant height (cm), number of leaves/plant, and leaf area (cm^2/plant) at regular interval after first spraying of growth regulators. The number of flowers/plant were counted after 5 days of first and second spray of growth regulators. All growth regulators tested enhanced the yield by retaining flowers better than control but application of NAA-20 ppm was superior than 2-4-D and KNO_3 . The significantly highest plant height (cm) and leaf area (cm^2/plant) were recorded in NAA-20 ppm and lowest in control. The flowering pattern were influenced by application of various concentration of NAA, 2-4-D and KNO_3. The significantly highest NR activity were recorded in all the treatment of NAA followed by2-4-D and KNO_3.The significantly maximum Chlorophyll content were observed in NAA 20 ppm followed by 2-4-D and KNO_3.The significantly highest grain yield (g/plant) recorded in NAA-20 ppm and 30 ppm followed by all the concentration of 2-4-D and KNO_3.*

INTRODUCTION

Soybean (*Glycine max* L.) is the leading oil seed crop of the world in terms of both area and production. In the recent years, Soybean has become an important crop in India since it yields oil, protein and also other industrial products yielding crop. Growth regulators are reported to have an effect on morphological parameters of soybean (Senthil, 2003). Yield potential of pulses is greatly affected by non-leaf synchronous habit, flower drop, nodule disintegration at the time of flowering, heavy senescence at the time of pod development, excessive vegetative growth in response to excessive irrigation and less fruit setting in lower branches of the plant (Sinha, 1974; Chaturvedi *et al*., 1980). Growth regulators are effective in several crops and found to balance the source and sink relationship, leading to increase in the yield of crops (Cheema *et al*., 1987). Plant growth regulators are found to enhance growth and physiological activity of the plant (Reena *et al*., 1998).

Exogenous application of growth regulators is one approach to improve crop productivity (Pando and Srivastava, 1985). Plant growth regulators play

* College of Forestry, V.C.S.G. Uttarakhand University of Horticulture and Forestry, Tehri Garhwal, Uttarakhand, *E-mail: drrgupadhyay11@gmail.com*

an important role in circumventing limitation to improve production. According to Basole *et al*. (2003) the yield of soybean can be enhanced through physiological growth manipulation by way of foliar application of growth regulators like NAA and nutrients like KNO_3, $ZnSO_4$. The foliar application of nutrients and hormones to certain extent can help in making available the required nutrients to crop for optimum growth and productivity under adverse conditions of soil. The pulse and oil seed crop yields are very poor and this discourages the wide cultivation of it. The plant normally produces large number of flowers but most of them abscise and fruit setting is controlled by many factors. So the use of growth regulators proved better to increase the yield. In the present experiment the effect of growth regulators NAA, 2, 4-D and nutrient KNO_3 were investigated on growth parameters, biochemical constituents, yield of Soybean during changing scenario of climate under mid hill conditions of North Western Himalayas during kharief season 2014.

MATERIAL AND METHODS

The pot experiment was conducted in the College of Forestry, Uttarakhand University of Horticulture and Forestry during Kharif, 2014 to assess the effect of foliar application of growth regulators (NAA,2,4-D and KNO_3) on growth parameters, biochemical constituents and yield of Soybean during kharief season 2014 in completely randomized block design (CRBD) with three replications and ten treatments comprised T_1-control, T_2-NAA-10 ppm, T_3-NAA-20 ppm, T_4-NAA-30 ppm, T_5-2-4-D-10 ppm, T_6—2-4-D-20 ppm, T_7-2-4-D—30 ppm, T_8- KNO_3-100ppm, T_9- KNO_3-200 ppm, T_{10}- KNO_3-300ppm.The seeds of soybean (c.v. Harit Soya) were sown in 30 pots and these were used to record the growth observations at 15 days interval *i.e.* 45, 60, 75, 90 days after sowing (DAS) and at harvest. The growth regulators and KNO_3 were sprayed at bud initiation and 50 per cent flowering stage of crop. The yield and yield contributing characters were recorded after harvesting of the crop. The nitrate reductase activity was calculated on the basis of formula given by Nicholas and Nason, (1957). The Chlorophyll content in leaves was estimated with Dimethyl Sulphoxide (DMSO) method by Hiscox and lsraelstam (1979).

Samples comprising of 1000 grains were drawn irrespective of shape and size from the produce of each pot and weight. Weight of 1000 grains was recorded. The total seed yield was separately weighted (g/plant) to obtain the grain yield per plant.

The harvest index was calculated by the formula given by Donald and Hamblin (1976).

RESULTS AND DISCUSSION

Significant increase in plant height was observed with the application of growth regulators at all stages of crop (Table 1). At 45 DAS there was slow increase in plant height with the treatments of growth regulators. Thereafter a tremendous increase in plant height was noticed till 90 DAS. Among all the treatments NAA with 20 ppm (T_3) concentration showed maximum plant height followed by NAA @ 10 (T_2) and 30 (T_4) ppm, 2, 4-D - 20 ppm (T_6), 10 ppm (T_5) and 30 ppm (T_7) and KNO_3 - 200 ppm (T_9), 100 ppm (T_8) and 300 ppm (T_{10}) treatments respectively at all the developmental stages. While lowest plant height was obtained in control at all the developmental stages. All the treatments increased the plant height significantly higher than that of control (Table -1). This implies that linearity of the plant is directly related to the endogenous level of auxin concentration. Similar results were obtained by Singh and Saxena (1972) who reported, greater plant height at lower concentrations of NAA, while at higher concentrations height decreased due to reduction in membrane permeability. It is evident from the data in Table.1 that all treatments were effective to increase number of leaves per plant over control. Treatment of 20 ppm (T_3) of NAA was found significantly superior over all the treatments and control during 45, 60, 75, 90 DAS & at harvest. Number of leaves per plant increased with time in all the treated plants till 75 DAS. Slow increase in number of leaves per plant by the application of treatments was observed at 45 DAS. With respect to increase in number of leaves per plant, highest number of leaves per plant was obtained in NAA treatments followed by 2, 4-D and KNO_3 treatments (Table 1). Increase in number of leaves per plant might be due to the reason that growth regulators might have contributed to enhanced source-sink relationship.

Number of branches per plant were also influenced with the treatments at three stages of development *i.e.* bud initiation (40 DAS), flowering (60 DAS) and maturity stage (90 DAS) (Fig. 1). No marked increase in number of branches per plant was obtained with the application of growth regulators and KNO_3 at bud initiation stage (45 DAS). It is revealed from the figure that highest number of branches per plant was observed in treatment of NAA with 20 ppm concentration (T_3) and lowest in control (T_1). All the treatments were significantly higher than that of control (T_1). In respect of increase in number of branches per plant, highest number was obtained in NAA - 20 ppm (T_3), 10 ppm (T_2) and 30 ppm (T_4) treatments followed by 2, 4-D - 20 ppm (T_6), 10 ppm (T_5) and 30 ppm (T_7) and KNO_3 - 200 ppm (T_9), 100 ppm (T_8) and 300 ppm (T_{10}) treatments, respectively.

Table 2 shows that early flowering was achieved by the application of growth regulators. The treatment 20 ppm (T_3) of NAA hastened the flowering effectively as compared to other treatments followed by 10 (T_2) and 30 ppm (T_4) of NAA. These NAA treatments were in turn followed by 2, 4-D - 20 (T_6), 10 (T_5) and 30 ppm (T_7) and KNO_3- 200 (T_9), 100 (T_8) and 300 ppm (T_{10}). Maximum days to 50 and 100 per cent flowering were observed in control. Upadhyay, (2002) observed the same findings with the application of NAA @ 20 ppm which showed significant early flowering over control. Earliness of flowering is desirable feature to escape lower temperature at the time of maximum flowering. The results are supported by Leport *et al* (1999) who suggested that early flowering would benefit yield if flowers were fertile, leading to early pod development and seed filling and thus, avoiding terminal soil moisture stress as in the case of chilling tolerant genotypes.

It is revealed from the Table 2, that number of flowers at 50 and 100 per cent flowering increased significantly by the application of growth regulators and KNO_3 as compared to control. Highest numbers

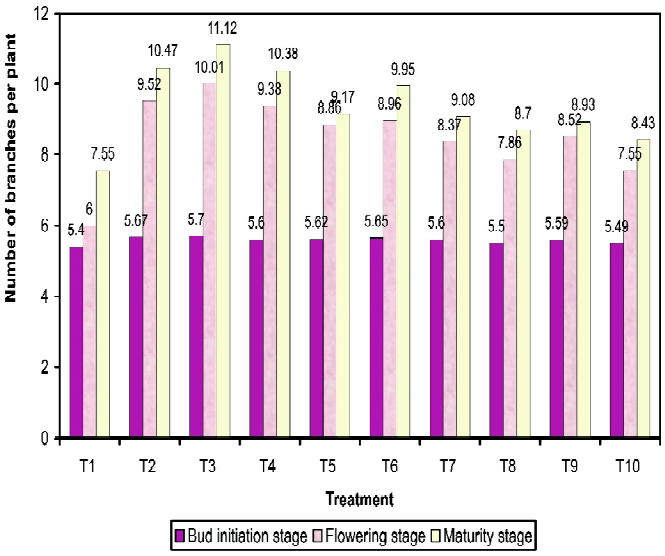

Figure 1: Effect of growth regulators on number of branches per plant

Table 1
Effect of growth regulators on plant height (cm) and number of leaves of Soybean

Treatment	*Plant height /plant (cm)*					*Number of leaves/plant*				
	45 DAS	*60 DAS*	*75 DAS*	*90 DAS*	*Harvest*	*45 DAS*	*60 DAS*	*75 DAS*	*90 DAS*	*Harvest*
T_1 (Control)	43.1	49.0	55.0	65.0	66.0	23.73	29.73	39.56	39.00	14.55
T_2 (NAA 10 ppm)	43.9	55.9	64.1	71.5	73.3	23.90	37.94	47.31	45.53	17.78
T_3 (NAA 20 ppm)	44.2	57.2	66.2	74.0	75.9	24.80	39.30	49.56	47.76	18.01
T_4 (NAA 30 ppm)	43.7	55.2	63.0	70.2	71.9	23.80	37.41	46.15	45.25	17.44
T_5 (2, 4-D 10 ppm)	43.5	54.3	61.5	68.3	69.8	23.84	35.93	45.58	44.67	16.24
T_6 (2, 4-D 20 ppm)	43.7	54.9	62.5	69.5	71.1	24.00	36.83	46.12	45.08	16.49
T_7 (2, 4-D 30 ppm)	43.4	53.6	60.7	67.3	68.7	23.80	35.50	45.29	44.01	16.18
T_8 (KNO_3 100 ppm)	43.4	52.8	59.6	66.0	67.2	23.79	34.33	44.23	43.23	15.77
T_9 (KNO_3 200 ppm)	43.5	53.5	60.5	67.0	68.3	23.80	34.96	45.17	43.88	15.91
T_{10} (KNO_3 300ppm)	43.3	52.3	58.9	64.7	65.8	23.75	34.00	44.17	42.33	15.67
CD at 5%	NS	1.2	1.1	1.3	1.2	NS	0.80	0.81	0.61	0.43

Table 2
Effect of growth regulators on days to flowering and flower development of soybean

Treatment	*Days to 50% flowering*	*Days to 100% flowering*	*Number of flowers at 50% flowering*	*Number of flowers at 100% flowering*	*Number of shed flowers at 100% flowering*
T_1 (Control)	52.60	58.11	32.0	52.8	28.0
T_2 (NAA 10 ppm)	49.30	53.55	41.2	74.0	17.0
T_3 (NAA 20 ppm)	48.00	52.00	47.0	82.6	12.2
T_4 (NAA 30 ppm)	49.90	54.00	39.2	72.5	20.0
T_5 (2, 4-D 10 ppm)	50.20	54.08	37.4	69.2	19.2
T_6 (2, 4-D 20 ppm)	50.00	53.90	38.3	72.0	18.5
T_7 (2, 4-D 30 ppm)	50.66	55.33	37.0	67.0	20.0
T_8 (KNO_3 100 ppm)	51.00	56.66	36.5	62.0	24.9
T_9 (KNO_3 200 ppm)	50.00	55.30	36.9	66.0	24.0
T_{10} (KNO_3 300ppm)	51.50	57.00	36.1	61.0	22.1
CD at 5%	0.76	0.96	0.5	1.7	0.6

of flowers were observed in pots treated with NAA – 20 ppm (T_3) at 50 and 100 per cent flowering, respectively, while lowest numbers of flowers were obtained with control at 50 and 100 per cent flowering respectively. With respect to increase in number of flowers per plant, highest number were obtained in NAA treatments followed by 2,4-D and KNO_3 treatments.They found that the foliar application of NAA (20 ppm) had significantly increased the total number of flowers formed per plant (75%) as compared to unsprayed plants.

Number of shed flowers at 100 per cent flowering were minimum in pots treated with NAA -20 ppm followed by 10 ppm of NAA (Table 2). Number of shed flowers were same in treatments NAA with 30 ppm concentration and 2, 4-D with 30 ppm concentration. Maximum flowers shedding were observed in control. Similar results were recorded by Upadhyay, 1994 that NAA prevents flower drop by preventing the formation of the abscission layer. Effectiveness of NAA to check the flower drop may be due to creation of favourable balance of endogenous hormone relative to flowering which inhibits abscission accelerating enzymes like cellulases, succinic dehdrogenases, RNA ase, Malic dehydrogenases etc, Auxin induced nucleic acid synthesis to create better reproductive structure (Moore, 1980 and Addicot, 1977).

It is evident from the observations presented in the table 3 that the marked improvement was brought towards the test weight of soybean due to influence of growth regulators. The significantly highest 1000 grain weight was recorded in the concentration of NAA-20 ppm followed by its remaining concentrations of 10 and 30 ppm which in turn were followed by all the concentration of 2, 4-D and KNO3. Among treatments lowest test weight was observed in control.

Economic yield markedly increased with the treatments of growth regulators (Table 3) .The significantly highest grain yield was recorded in NAA 20 ppm while lowest was observed in control. The significantly highest grain yield were recorded in NAA (20,10 and 30 ppm) followed by 2,4-D (20,10 and 30 ppm) and KNO3 (200,100 and 300ppm) treatments, respectively.

It is evident from the mean values in table 3 that marked improvement was brought towards biological yield of Soybean due to influence of growth regulators. Maximum biological yield was obtained in post treated with NAA concentration of 20 ppm followed by 10 and 30 ppm concentration of the same growth regulator which in turn were followed by 2,4-D (20,10 and 30 ppm) and KNO3 (200, 100 and 300 ppm) respectively. Minimum biological yield was observed in control. Thus form the above observations it appears that highest biological yield was recorded with all NAA treatments followed by 2,4 –D treatments and KNO3 Treatments.

It is evident from the table 3 that highest harvest index was recorded in NAA 20 ppm followed by its 10 and 30 ppm concentrations and 2,4-D (20,10 and 30 ppm) and KNO3 (200,100 and 300ppm) Treatments, in respective manner. Lowest harvest index was recorded in control.

Table 3
Effect of growth regulators on Grain yield and its attributes

Treatment	*Test weight (g/plant)*	*Grain yield (g/plant)*	*Biological yield (g/plant)*	*Harvest index (%)*
T_1(Control)	129.21	13.01	36.61	35.54
T_2 (NAA 10ppm)	166.81	23.68	49.30	48.03
T_3(NAA 20ppm)	174.67	25.83	51.60	50.06
T_4 (NAA 30ppm)	164.40	22.68	46.20	49.09
T_5(2,4-D 10ppm)	162.47	21.36	43.90	48.66
T6(2,4-D 20ppm)	163.10	22.09	46.10	47.92
T_7(2,4-$D_3$0ppm)	159.33	20.30	42.40	47.88
T_8 (KNO_3 100ppm)	143.60	16.60	41.66	39.85
T_9(KNO_3 200ppm	146.68	19.60	43.80	44.75
T_{10}(KNO_3 300ppm	141.54	15.30	39.40	38.83
CD(5%)	1.146	0.45	0.52	1.16

Table 4
Effect of growth regulators on total chlorophyll (mg/ml) and nitrate reductase activity (µ MNO3 reduced/ g fr. Wt. /h) in leaves of soybean

Treatment	*Days after sowing (DAS)*				*Vegeta-tive stage*	*Flowe ring stage*	*Matu-rity stage*
	45	*60*	*75*	*90*	*30*	*60*	*90*
T_1(Control)	9.02	10.00	5.30	3.06	0.243	0.315	0.157
T_2 (NAA 10ppm)	9.20	11.60	7.61	4.76	0.253	0.369	0.199
T_3(NAA 20ppm)	9.24	12.84	7.80	4.89	0.256	0.400	0.215
T_4 (NAA 30ppm)	9.19	11.59	7.57	4.75	0.250	0.368	0.197
T_5(2,4-D 10ppm)	9.12	11.55	7.00	4.72	0.250	0.355	0.195
T6(2,4-D 20ppm)	9.16	11.58	7.02	4.74	0.248	0.360	0.200
T_7(2,4-$D_3$0ppm)	9.10	11.52	6.90	4.71	0.249	0.353	0.190
T_8 (KNO_3 100ppm)	9.05	11.45	6.70	4.69	0.247	0.341	0.185
T_9(KNO_3 200ppm)	9.07	11.48	6.72	4.70	0.246	0.349	0.189
T_{10}(KNO_3 300ppm)	9.04	11.43	6.65	4.67	0.244	0.340	0.182
CD(5%)	N.S	0.07	0.06	0.05	NS	0.07	0.08

All treatments increased total chlorophyll significantly at all stages except at 45 DAS where, increase was non-significant as compared to control. At all the developmental stages highest chlorophyll content was obtained with NAA-20 ppm followed by its concentration of 10 ppm and 30 ppm and 2,4-D(20,10 and 30ppm) treatments. Lowest total chlorophyll was recorded in control. All treatments showed significantly higher total chlorophyll content as compared to control. Nitrate reductase activity was recorded at three stages i.e. bud initiation flowering and maturity stage. Table 4 shows that nitrate reductase activity in the soybean leaves exhibited significant increase from vegetative (45 DAS) to flowering stage (60DAS) where as at maturity (90 DAS) it decreased to minimum level. At vegetative stage (45 DAS) treatments did not differ significantly from control. At all stages highest nitrate reductase activity was found in NAA when applied @ 20 ppm followed by its 10 and 30 ppm respectively ad lowest in control. All the treatments showed significantly higher nitrate reductase activity as compared to control.

References

Addicot, F.T. and Wiar, (1977), ln plant growth regulation. Edited by P.E. Pilet. Pub. Springe-versy pp. 249-257.

AOAC. (1970), Official methods of Analysis of the Association of Office Analyticla chemists. 11th edition , Washington, D.C.

Basole, V.D., Deotale, R.D., Iimulwar, S.R., Raut, S.S. and Kandwe, S.B. (2003), Effect of hormones and nutrients on morphological characters and yield of soybean. Journal of Soils and Crops 13(1): 135-139.

Chaturvedi, G.S., Agarwal, P.K. and Sinha, S.K. (1980), Growth and yield of determinate and indeterminate cowpea in dry land agriculture. Journal of Agricultural Sciences 942, 137-144.

Cheema, S.S.H., Singh and Sahota, T.S. (1987), Growth regulators for improving crop productivity, pp. 91-115. (Editors Srivastva, H.S. Bhaskaran, S. and Memon, K.K.G), Oxford and IBH Publishers.

Deotale, R.D., Maske, V.G., Sorte, N.V., Chimurkar, B.S. and Yerne, A.Z. (1998), Effect of GA_3 and NAA on morphophysiological parameters of soybean. Journal of Soils and Crops 8(1): 91-94.

Hiscox, J.D. and lsraelstam, G.F. (1979), A method of extraction of chlorophyll form leaf tissues without maceration. Canadian journal of botany 51:1332-1334.

Leport L, Turner N C, French R J, Barr M D, Duda R, Davies S L, Tennant D and Siddique K H M (1999), Physiological response of chickpea genotypes to terminal drought in a mediterranean-type environment. *Euro J Agron* **11**: 279-291.

Moore, T.C. (1980), *ln*: Biochemistry and physiology of plant hormones. Publication, Narosa Publishing house, New-Delhi, pp. 32-89.

Nichlas, D.J.D. and nason A. (1957), Determination of nitrate and nitrite. Methods in enzymology pp. 981-984.

Pando, S.B. and Srivastava, G.C. (1985), Physiological studies on seed set in sunflower significance of dwarfening the plant size using growth regulators. Indian Journal Physiology 28: 72-80.

Parkasa, R.J.S. and Narayanan, A. (1997), Effect of water and light stress and foliar application of auxins on flower abscission and seed yield of pigeon pea. Madras Agricultural Journal 84(3): 127-129.

Reena, T., Deotale, R.D., Sable, S., Chore, C.N. and Tagade, R. (1998), Influence of seed soaking in IAA and Kinetin solutions on growth and yield of soybean. Journal of Soils and Crops 8(2): 172-175.

Senthil, A., Pathmanaban, G. and Srinivasan, P.S. (2003), Effect of bioregulators on some physiological and biochemical parameters of soybean. Legume Research 26(1): 54-56.

Singh, M.P. and Saxena, M.C. (1972), Field study and nitrogen fertilization of soybean. Indian Journal of Agricultural Sciences 42(11): 1028-1031.

Sinha, S.K. (1974), Yield of grain legumes problems and prospects. Indian Journal of Genetics and Plant Breeding 34(A): 988-994.

Upadhyay, R.G. (1994), Effect of bioregulators on growth, development, flowering behavior and yield of chick pea (*Cicer arietinum*). Legume Research 17(1): 60-62.

Upadhyay, R.G. (2002), Response of growth regulators on flower drop, fruit setting, biochemical constituents and yield of chick pea (*Cicer arietinum*) under mid hill conditions of H.P. Legume Research 25(3): 211-214.

Warade, S.D. and Singh, K. (1977), Effect of planofix on control of flower drop and fruit set in chillies (*Capsicum annum* L.) Abstract on Tropical Agriculture 17(3): 24-26.