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EFFECT OF INDOLEACETIC ACID (IAA) AND BENZYLADININE (BA) ON GROWTH AND YIELD OF SOYBEAN (*Glycine max* (L.) Merril).

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ABSTRACT

This investigation was carried out during the two successive seasons of 2006 and 2007 at the Agricultural Experimental and Research Station, Faculty of Agriculture, Cairo University Giza, Egypt. to study the effect of IAA and BA on vegetative growth and yield of soybean plant. Three concentrations, 50,100 and 200 ppm. were used of each growth regulator. The results revealed that IAA or BA increased main stem length, number of branches and leaves per plant, dry weight of leaves, stems and pods per plant, number of mature pods and seeds per plant and seed yield per plant. Number of main stem internodes, total leaf area per plant and weight of 100 seeds were not affected by treatment.

INTRODUCTION

Soybean (*Glycine max* (L.) Merril) is a very widely oil and protein seed crop. It has a highly nutritive value, containing about 42-45% protein and 20-25% edible oil. It used as a good source of unsaturated fatty acids, minerals (Ca and P) and vitamins (A,B,C and D). (Rahman, 1982)

Auxins plays an important role in the regulation of plant growth and developmental processes, including elongation, apical dominance, lateral root differentiation, the differentiation of vascular tissues, embryogenesis and fruit ripening (Arteca 1996). These responses can be manipulated quite precisely by the applications of exogenous auxins. Many investigators reported positive effects of auxins on growth and yield of several crop plants (Fasheun and Dennett, 1982, on faba bean; Baz *et al,* 1984, on soybean; Singh and Rathore, 1988, on mung bean; Salem, 1989, on soybean; El-Bassiouny and Shukry, 2001, on cowpea; El-Abd *et al*, 1989, on faba bean; Reddy and Majumder, 2004, on *Vigina mungo*; Tomar and Singh, 2005, on *Pisum sativum*; and Deotale *et al* 2005, on *Vigna radiat*)

There are many cytokinins found in plants, however, the genus, species and other factors will determine which cytokinin is most effective in affecting a given response. The following are a list of biological responses which cytokinins have been shown to be involved in: cell division, organ formation, cell and organ enlargement, retardation of chlorophyll breakdown, chloroplast development, delay of senescence, stomatal opining and closing, bud and shoot development, and preferential translocation of nutrients and organic substances to cytokinin treated tissues (Arteca 1996).

There are many synthetic cytokinins known to day, however, three common examples are: kinetin (6-furfurylaminopurine), BA (6-benzylaminopurine) and BPA (6-[benzylamino]-9-[2-tetrahyropyranyl]-9-H-purine). (Arteca 1996)

Many investigators found beneficial effects of BA on growth and yield of soybean and other plant species (Salem, 1989; Mansour *et al*, 1994; Nagel *et al*, 2001; Patil *et al*, 2002; and Kaori *et al* 2007, on soybean, and Li and Bangerth 2003 on pea).

The current investigation was carried out to study the effect of foliar application of Indoleacetic acid (IAA) and Benzyladenine (BA) on growth traits and yield of soybean.

MATERIALS AND METHODS

This investigation was carried out during the two successive seasons of 2006 and 2007 at the Agricultural Experimental and Research Station, Faculty of Agriculture, Cairo University, Giza, Egypt.

Soybean cultivar, Giza 111 was used in this study. Seed were secured from the Crop Research Section, Agric. Research Center, Ministry of Agriculture, Giza, Egypt.

Two growth regulators were used in the current investigation IAA (Indoleacetic Acid) and BA (6-benzylaminopurine) 98.5% commercial formulation was obtained as powder from Roth Company. Four concentrations of IAA and BA namely, 0.0 (control), 50, 100 and 200 ppm were used for spray application. soybean plants were treated with foliar spray by IAA once at 37and 39 days from sowing in the first and second growing seasons respectively, 38 and 40 days from sowing in two growing seasons respectively, for BA.

The experiment layout was (Randomized Complete Block Design) with three replicates for each treatment. Seeds were sown on May 28th in the two seasons and sown in ridges 60 cm apart.The usual farming procedures for the crop in the locality were followed. Seeds were drilled in bottom of ridge with seeding rate of 35 kg/feddan.

The following morphological traits were studied at three sampling dates in each of the two growing seasons except the dry weight of shoot and pods, number of leaves and total leaf area/plant, which examined at one sampling date: main stem length, number of main stem internodes, diameter of main stem, number of branches per plant, number of leaves/plant, total leaf area/plant and dry weight of shoot and green pods/plant. Yield and yield components were estimated at maturity.

Morphological and yield characters subjected to appropriate analysis of variances as reported by Snedecor and Cochran (1982)

RESULTS AND DISCUSSION

I- Effect of IAA and BA on growth traits of soybean.

1- Main stem length:

The different concentrations used of IAA in the two growing seasons significantly increased the length of main stem. The stimulative effect of IAA on main stem elongation was more pronounced when the two lower rates 50 and 100 ppm were used comparing with the highest rate 200 ppm. Table (1) and (2).

Table (1): The length of main stem (cm) of soybean plant as affected by treatment with IAA.

Season / Conc.	First Season			Second season		
	60 days	83 days	140 days	62 days	85 days	142 days
Cont.	61.47	94.07	102.00	65.67	101.00	102.11
50 ppm	72.47	106.00	108.40	78.89	108.20	110.33
100 ppm	77.20	108.80	108.53	84.78	112.56	113.11
200 ppm	69.33	103.30	106.53	81.45	109.78	110.33
LS.D 0.05	**3.61**	**5.55**	**3.21**	**7.24**	**2.51**	**4.38**

BA included also promotive effect on the main stem extension. This effect was statistically significant at any of the three rates used in the second season when compared with control. The rate of 100 ppm of BA was the most effective dose in this respect (Table 2).

Table (2): The length of main stem (cm) of soybean plant as affected by treatment with BA

Season / Conc.	First Season			Second season		
	62 days	85 days	140 days	64 days	87 days	142 days
Cont.	63.67	94.13	101.20	65.89	99.00	102.22
50 ppm	74.80	105.13	106.20	77.66	106.11	107.89
100 ppm	69.07	107.18	108.67	80.66	109.78	111.33
200 ppm	64.13	97.82	102.40	77.33	107.78	108.56
LS.D 0.05	**9.080**	----	**5.039**	**7.024**	**6.128**	**5.352**

2- Number of main stem internodes:

Except at the first sampling date in each of the two seasons no significant differences in the number of main stem internodes were recorded between plants treated with IAA and BA and those untreated. Tables (3) and (4)

Table (3): Number of main stem internodes of soybean plant as affected by treatment with IAA.

Season / Conc.	First Season			Second season		
	60 days	83 days	140 days	62 days	85 days	142 days
Cont.	14.80	19.40	23.40	18.33	21.44	22.33
50 ppm	16.73	21.27	22.60	21.00	21.78	22.00
100 ppm	17.80	20.57	23.33	22.11	22.89	23.00
200 ppm	15.80	21.67	22.33	20.44	22.67	23.00
LS.D .05	**1.025**	----	----	**0.884**	----	----

Table (4): Number of main stem internodes of soybean plant as affected by treatment with BA.

season / Conc.	First season			Second season		
	62 days	85 days	140 days	64 days	87 days	142 days
Cont.	14.40	19.87	22.80	19.22	21.56	22.44
50 ppm	15.87	20.13	22.80	20.56	22.56	23.67
100 ppm	15.87	21.32	22.60	20.67	23.22	23.33
200 ppm	15.27	21.02	24.53	20.44	22.89	23.55
LS.D 0.05	**----**	**----**	**----**	**1.294**	**----**	**----**

3- Diameter of main stem:

No significant differences in main stem diameter were recorded between plants treated with IAA and those untreated. Treatment with BA tended to increase main stem diameter, specially at the two rates of 100 and 200 ppm in the second season where the effect was statistically significant. Table (5) and (6).

Table (5): Diameter of main stem (mm) of soybean plant as affected by treatment with IAA.

Season / Conc.	First Season			Second season		
	60 days	83 days	140 days	62 days	85 days	142 days
Cont.	7.23	7.97	8.53	7.53	8.17	9.25
50 ppm	7.37	7.68	7.98	7.53	8.25	9.64
100ppm	7.23	7.69	8.58	7.50	8.14	9.58
200ppm	7.13	8.07	8.50	7.55	8.08	9.30
LS.D0.05	----	----	----	----	----	----

Table (6): Diameter of main stem of soybean plant as affected by treatment with BA.

Season / Conc.	First Season			Second season		
	62 days	85 days	140 days	64 days	87 days	142 days
Cont.	6.88	8.02	7.60	7.31	7.94	8.92
50ppm	7.48	7.69	7.82	7.33	8.00	9.33
100ppm	7.70	7.75	7.78	7.44	8.17	9.69
200 ppm	7.10	7.81	8.35	7.53	8.25	9.61
L.S.D 0.05	**0.636**	----	----	----	**0.215**	----

4- Number of branches per plant:

IAA slightly affected the number of branches per plant. A significant increase was recorder only with the rate of 50 ppm in the second season comparing with control Table (7). BA was more effective in promoting branching of soybean plant. The different used concentrations increased this aspect comparing with control in the second season. The recorded increments in first season were mostly insignificant. Table (8).

Table (7): Number of branches per plant of soybean as affected by treatment with IAA.

Season / Conc.	First Season			Second season		
	60 days	83 days	140 days	62 days	85 days	142 days
Cont.	3.47	2.07	3.13	2.67	3.22	3.56
50 ppm	3.60	2.20	2.07	3.33	3.89	3.89
100 ppm	4.47	1.92	2.27	2.78	3.32	3.44
200 ppm	4.00	2.32	2.73	2.98	3.45	3.56
LS.D 0.05	**0.625**	----	----	**0.384**	**0.316**	----

Table (8): Number of branches per plant of soybean as affected by treatment with BA

Season / Conc.	First Season			Second season		
	62 days	85 days	140 days	64 days	87 days	142 days
Cont.	3.13	2.00	2.73	2.67	3.00	3.22
50 ppm	3.87	2.07	4.53	3.57	4.00	4.44
100 ppm	4.27	2.40	3.13	3.89	4.11	4.67
200 ppm	4.40	2.52	4.60	4.00	4.00	4.11
L.S.D 0.05	**1.235**	----	----	**0.863**	**0.889**	**1.258**

5- Number of leaves per plant:

The three rates of IAA or BA increased the number of leaves per plant. However, the differences between treated and untreated plants were statistically significant only in the second season for IAA. As to BA the differences between treated and untreated plants were statistically significant in the two seasons except at the second sampling date of the first season. Table (9) and (10).

Table (9): Number of leaves per plant of soybean as affected by treatment with IAA.

Season / Conc.	First season		Second season	
	60days	83 days	62 days	85 days
Cont.	21.60	20.93	23.44	28.89
50 ppm	23.93	24.00	27.89	32.56
100 ppm	26.47	24.62	27.89	32.22
200 ppm	24.87	25.78	29.00	33.55
L.S.D 0.05	----	----	**3.865**	**2.97**

Table (10): Number of leaves per plant of soybean as affected by treatment with BA.

Season / Conc.	First season		Second season	
	62 days	85 days	64 days	87 days
Cont.	19.80	21.80	24.56	29.67
50 ppm	24.87	22.73	28.89	33.11
100pm	27.13	25.32	31.22	33.33
200pm	26.53	23.78	30.22	32.89
L.S.D 0.05	**5.473**	----	**4.081**	**3.547**

6- Total leaf area per plant:

It is clear from tables (11) and (12) that application of IAA or BA did not significantly affect the total leaf area per plant in any of the two growing seasons.

Table (11): Total leaf area per plant (cm^2) of soybean as affected by treatment with IAA.

Season / Treat.	First Season (83 days)	Second Season (85 days) (days)
Cont.	3562.07	4162.15
50 p.p.m.	3363.93	4273.52
100 p.p.m.	3492.64	4354.12
200p.p.m.	3396.58	4524.96
L.S.D 0.05	----	----

Table (12): Total leaf area per plant (cm^2) of soybean as affected by treatment with BA.

Season / Treat.	First Season (85 days)	Second Season (87 days)
Cont.	3970.80	3988.72
50 p.p.m.	3940.28	4263.71
100 p.p.m.	3488.34	4346.69
200 p.p.m.	3310.90	4164.76
L.S.D 0.05	----	----

7- Dry weigh of shoot and pods per plant:

IAA increased the dry weight of leaves, stems and pods/plant. The differences between treated and untreated plants were statistically significant only with respect to the dry weight of pods per plant in both growing seasons. The most effective dose in this respect was 200 ppm in the first season and 100 ppm in the second one Table (13).

Table (13): Dry weight of shoot and pods per plant (gm) of soybean as affected by treatment with IAA.

Season / Treat.	First season				Second season			
	83 days				85 days			
	Leaves	Stem	Pods	Total	Leaves	Stems	Pods	Total
Con.	6.5	15.8	6.2	28.5	14.8	18.9	15.4	49.2
50 ppm	6.8	18.1	10.0	34.9	17.5	20.9	19.1	57.6
100 ppm	8.4	18.9	10.4	37.6	17.5	22.5	19.9	59.9
200 ppm	9.9	19.8	10.8	40.6	15.4	21.1	17.6	54.1
L.SD 0.05	**----**	**----**	**2.3**	**----**	**----**	**----**	**2.31**	**6.64**

No significant differences in dry weight of leaves, stems and pods/ plant were recorded between plants treated with BA and those untreated during the first season. In the second season these aspects were significantly increased due to treatment with any rate of BA comparing with control. The rate of 200 ppm BA was the most effective dose in this respect Table (14).

Table (14): Dry weight of shoot and pods per plant (gm) of soybean as affected by treatment with BA.

Season / Treat.	First season				Second season			
	85 days				87 days			
	Leaves	Stem	Pods	Total	Leaves	Stems	Pods	Total
Cont.	8.4	16.8	7.3	32.5	13.8	19.1	16.9	49.8
50 ppm	7.6	16.0	6.5	30.1	17.0	22.5	20.3	59.8
100 ppm	9.0	18.2	7.5	34.7	17.2	22.3	20.1	59.6
200 ppm	6.1	17.6	9.9	33.6	17.0	24.4	20.5	61.9
L.S.D. 0.05	----	----	----	----	**2.55**	**2.65**	**1.63**	**4.85**

II- Effect of IAA and BA on yield and yield components of soybean:

The different concentrations used of IAA significantly increased number of pods per plant number of seeds/plant and weight of seeds per plot comparing with control in both growing seasons. The other yield components, number of seeds/ pod, seed index and seed yield/ plant were also increase due to treatment with IAA but the differences between treated and untreated plants were statistically significant only in the second season, except seed index where the increments were insignificant in both seasons. Table (15)

Table (15): Seed yield and yield components of soybean plants as affected by treatment with IAA.

Season / Treat.	First season					
	No. Pods/Pl.	No. S. /Pod	No. S. /Pl.	Seed Index (gm)	S. yield/pl (gm)	Seed yield/ plot (gm)
Cont.	62.47	2.70	168.67	17.51	19.78	1201.00
50 ppm	70.60	2.75	194.15	18.30	22.41	1436.33
100 ppm	73.93	2.81	207.74	18.47	26.03	1479.67
200 ppm	75.33	2.81	211.68	18.66	24.80	1474.33
L.S.D 0.05	**8.21**	----	**24.55**	----	---	**193.2**

Season / Treat.	Second season					
	No. Pods/Pl.	No. S. /Pod	No. S. /Pl.	Seed Index (gm)	S. yield/pl (gm)	Seed yield/ plot (gm)
Cont.	89.33	2.78	248.34	20.13	38.64	1725.00
50 ppm	120.33	2.92	351.36	20.77	55.22	2441.67
100 ppm	114.78	2.96	339.75	20.74	54.94	2150.00
200 ppm	115.56	2.97	343.21	21.55	51.38	1925.00
L.S.D 0.05	**14.17**	**0.063**	**50.87**	----	**5.298**	**452.1**

Treatment with BA significantly increased number of pods/ plant, number of seeds/ plant and yield of seeds/ plant comparing with untreated control in both seasons. No significant differences in number of seeds/ plant and seed index were detected between treated and untreated plants in the two seasons. The different concentrations of BA increased the yield of seeds/ plot comparing with control with significant differences only in the second season Table (16).

Table (16): Seed yield and yield components of soybean plant as affected by treatment with BA.

Season / Treat.	First season					
	No. Pods /Pl.	No. S. /Pod	No. S./ Pl.	Seed Index (gm)	S. yield/pl (gm)	Seed yield/plot (gm)
Cont.	45.27	2.53	114.5	17.10	17.76	1143.00
50 ppm	56.93	2.73	155.4	17.14	20.77	1387.67
100 ppm	57.27	2.61	149.5	16.87	21.91	1286.67
200 ppm	60.93	2.61	159.0	17.09	23.29	1362.67
L.S.D 0.05	**10.26**	**----**	**39.43**	**----**	**2.80**	**----**

Season / Treat.	Second season					
	No. Pods/Pl.	No. S. /Pod	No. S. /Pl.	Seed Index (gm)	S. yield/pl (gm)	Seed yield/plot (gm)
Cont.	91.89	2.81	258.21	19.76	40.04	1626.67
50 ppm	115.22	2.86	329.5	20.93	50.24	2241.67
100 ppm	119.65	2.92	349.٤	21.05	55.02	2366.67
200 ppm	116.67	2.88	336.0	20.89	56.02	2376.67
L.S.D 0.05	**13.44**	**----**	**54.06**	----	**7.10**	**516.00**

It could be concluded therefore, that foliar application of IAA at 50, 100 or 200 ppm to soybean plant induced promotive effect on main stem elongation. However, the rate of 100 ppm IAA was the most effective dose in this respect. The final number of main stem internodes showed no significant response to treatment with IAA. This led to the suggestion that the increase in main stem length of treated plants was due mainly to the promotive effect of the auxin on elongation of the individual internode. The enhancement of stem elongation due to treatment with IAA was recorded by many workers (Baz *et al* 1984, Salem 1989 and Sarkar *et al* 2002 on soybean; El- Abd *et al* 1989, on faba bean; El- Bassiony and Shukry 2001, on cowpea; Reddy and Majumder 2004, on black gram; Deotale *et al* 2005, on *Vigna radiate*).

Number of branches and leaves per plant and dry weight of plant shoot and pods/ plant tended to increase with IAA treatments. These results are more or less in accordance with the findings of El- Abd *et al* (1989), Salem (1989), El-Bssiouny and Shukry (2001) and Sarkar *et al* (2002). Leaf area per plant showed no significant response to IAA treatment, in accordance with the results of Salem (1989). While Sarkar *et al* (2002) found an increase in total leaf area of IAA treated soybean plant.

Seed yield per plant and most of yield components specially number of pods per plant were significantly increased with the application of IAA .This result confirm the results of Singh and Rathore (1988), Salem (1989), El-Bassiouny and Shukry (2001) and Sarkar *et al* (2002).

From the foregoing results, it could be concluded that benzyladenine (BA) stimulated the growth of main stem in length and width. Number of branches and number of leaves per plant as well as dry weight of plant shoot were increased due to treatment with BA. This promotive effect of BA on vegetative growth might be reflected on the development of reproductive parts and consequently the seed yield significantly increased. The stimulative effect of BA on vegetative growth and seed yield of soybean was formerly reported by Salem 1989, Mansour *et al* (1994) and Patil *et al* (2002).

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تأثير منظمى النمو اندول حامض الخليك (IAA) والبنزيل ادنين (BA) على نمو ومحصول فول الصويا.

عبد الفتاح إبراهيم الشعراوى، عاطف زكريا السيد سبع، سوسن محمود أبو طالب و أحمد عيسى غنيم

قسم النبات الزارعى – كلية الزراعة – جامعة القاهرة – جيزة – مصر

اجرى هذا البحث خلال الموسمين الزراعيين ٢٠٠٦/٢٠٠٧ فى محطة التجارب والبحوث الزراعية لكلية الزراعة- جامعة القاهرة لدراسة تأثير منظمى النمو اندول حامض الخليك (IAA) والبنزيل ادنين (BA) على النمو الخضرى والمحصول لنبات فول الصويا. تم استخدام ثلاث تركيزات ٥٠، ١٠٠، ٢٠٠ جزء فى المليون من كل من منظمى النمو. أظهرت النتائج حدوث زيادة فى كل من طول الساق الرئيسى وعدد الأفرع وعدد الأوراق للنبات نتيجة للمعاملة. كما ادى استخدام منظمى النمو المذكورين الى حدوث زيادة فى الوزن الجاف لكل من الأوراق والسوق والقرون للنبات وكذلك عدد القرون الناضجة وعدد البذور للنبات. أوضحت النتائج ايضا عدم تأثر كل من مساحة الاوراق الكلية للنبات وكذلك وزن المائة بذرة نتيجة للمعاملة.