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Cowpea growth pattern, metabolism and yield in response to IAA and biofertilizers under drought conditions.

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ABSTRACT

Cowpea plants were grown in the arid Nubaria region in Egypt. The soil was supplemented with organic manures, either chicken (CKM) or farmyard (FYM). Foliar application of the plants with indole acetic acid (IAA) at three concentrations (12.5, 25 & 50 ppm) induced increments of the plants height, fresh and dry weights, number of branches and number of leaves/plant as well as yield components (pods/plant, seeds/pod, weight of pod, weight of seeds/plant and weight of seeds/feddan). In addition, the same treatments induced a drought defense mechanism by increasing the accumulation of organic solutes such as sugars, proline and total soluble nitrogen and inorganic solutes (K, Na, Ca, Mg, Zn, Fe and Cu) in the leaves and seeds. Meanwhile the same treatments induced a reduction in the Mn, Pb and Ni contents. The effect of organic fertilizers (CKM and FYM) showed a significant increase in all the mentioned parameters when compared with a control. Meanwhile, the presence of different IAA concentrations with manure induced a highly significant increase in all mentioned parameters.

KEYWORDS: Cowpea, chicken manure, farmyard manure, IAA.

INTRODUCTION

Some regions of the world, such as parts of the Sahara Desert of Northern Africa receive an average of 5 mm of rainfall or less per year. This extreme aridity is atypical of the arable land which is used for crops or pastures as in the Nubariya area (near Alexandria) in Egypt. Nonetheless, most of the world's agriculture is subjected to drought problems. Arid and semi-arid zones are defined as areas in which plant transpiration is about 50% or less than the transpiration that would normally occur, in response to the limited water availability.

In these areas water is the major factor limiting plant growth. This water stress may be alleviated by irrigation whenever possible (Boyer 1982) or by using certain bioregulators such as IAA (Yadav *et al*. 1991). Agarwal & Gupta (1995) showed that IAA suppressed the salt stress and in turn its injuries by lowering osmotic potential and maintaining cellular turgidity. In the meantime proline, soluble amino acids, sugars insoluble sugars and proteins were increased by this growth regulator. Moreover, Pustovoitova *et al*. (2000) stated that the higher drought tolerance of the transgenic tobacco plants *Nicotiana silvestris* is related to IAA involvement in plant adaptation, that is, in the hormone induced modification of plant hormonal status and the osmoregulation process. Plant hormones have much to offer in improveing crops quantitatively and qualitatively. In the meantime, plant hormones are a useful tool in saving irrigation.

The incubation of sand loam soil was supplemented with either farmyard or chicken organic manures in order to overcome the drought stress on plants. Sadovnikova *et al*. (1996) found that the organic manure plays two roles both physical and chemical. The organic manures can improve the properties of soil exposed to drought by increasing the limited moisture holding capacity (Maynard 1994). Whereas the soil mixed with organic meanures, these manures are hydrophilic organic material, its use help to dissolve some problems related to the low water retention and water holding capacity of sandy soils which in turn increase the capacity to store the water needed to plant growth in such coarse textured soils and its consider as soil conditioners. In addition to this effect, it can change the chemical properties of soil through increasing the soil pH, C/N ratio, cation exchange capacity and ion uptake (Bvoungyeul *et al*. 1996). All these factors have a positive effect on the growth of groundnut (Hafner *et al*. 1992), yield of saybean (Ramamurtry & Shivashankar 1996), the protein quantity of the cowpea seeds produced. (Kumer *et al*. 1993) and the rate of nutrient uptake from the soil by potata, (Sood *et al*. 1994). The combination of IAA with mannure, increased the efficiency of plant to use all the nutrients in soil supplemented with organic mannure Hsich & Hsu (1993) and Hathout *et al*. (1993).

The aim of the present study is to assess the effect of water stress on the growth metabolism and the yield of cowpea plants. In addition, it aims to throw more light on the role of IAA, organic manures (CKM or FYM and their combinations) on overcoming this stress.

MATERIALS AND METHODS

Two field experiments were carried out during two successive seasons at El-Bostan village, Nobarea area, Tahrir province, Egypt. The mechanical and chemical analysis of the experimental field soil are presented in Table 1. The soil is sandy in texture, has a low level of nutrients and its pH appears to be neutral (Jackson 1958).

A split plot design was followed with four replicates. The experimental area was divided into three plots (each 4 x 40 m) two of which were alloted for the manures and the third left as a control. Two types of manures were used, namely chicken manure (CKM) and farmyard manure (FYM) one for each of the designated plots, where the former was applied at 5 m^3/Fed and the latter at 10 m^3/Fed (fed. = 4200 metr). Each manure was mixed at the depth of 10 – 15 cm in the seed pits after soil preparation. Each plot was divided to four subplots. The plants of each subplots were sprayed twice (30 and 37 days after sowing) with the following indole acetic acid (IAA) concentrations 0.0, 12.5, 25 and 50 ppm.

Table 1. Mechanical and chemical analysis of Nubaria soil at the experimental sites.

Components	Values
Mechanical analysis	
Soil fractions	
Sand %	77.9
Silt %	14.5
Clay %	5-10
Texture class	Sandy
Chemical analysis	
pH	7.45
E.C.	0.730 m S/cm
$CaCO_3$%	1.80
Mg^{++}	1.0 meq/100 g soil
Na^{+}	1.3 meq/100 g soil
K^{+}	0.05 meq/100 g soil
Total nitrogen	150.0 ppm

The plant samples were taken 2 months after sowing and shoot length, number of branches and leaves/plant, fresh and dry weights increased. The yield measurements and its components were also recorded (number of pods/plant, number of seed/pod, number and weight of seed/plant, weight of pods/plant and the seed yield (Kg/feddan).

The data of the different treatments were subjected to statistical analysis. Two-way ANOVA with factors Randomized Complete Block Design were carried out. (Snedecor & Cochran 1980).

Chemical analysis: The methods of carbohydrates extraction and clarification were essentially those described by Younis *et al*. (1969). The direct reducing value (D.R.V.) were determined following the procedure of Bell (1955). The total reducing value (T.R.V.) were estimated by determining the optically density after hydrolysis by invertase. The sucrose contents was calculated from the difference between T.R.V. and D.R.V. Polysaccharides were determined in the dry residue which was left after the extraction of soluble sugars using the method adopted by Younis *et al*. (1969).

Total-N and total soluble-N were estimated by the conventional micro-kjeldahle method (Pirie 1955). Subtracting the total soluble-N from the total-N gave the value of protein-N. Cation estimation was carried out according to Chapman and Pratt (1978). Flamemssion spectrophotometry was used for determining potassium and sodium while calcium, magnesium, zinc, iron, manganese, copper, lead and nickel were measured by atomic absorption spectrophotometry. Identification and quantitative determination of the amino acid composition of the cowpea protein was carried out by high performance liquid chromatography (HPLC).

RESULTS AND DISCUSSION

Growth measurements: Fig. 1 shows the following growth criteria; shoot length, number of branches/plant, number of leaves/plant and fresh and dry weights. These parameters were accelerated in comparison to the control as a response to the applied treatments of the different IAA concentrations (12.5, 25 and 50 ppm), where there were a positive correlation with the concentration. Similar results were reported by Stefl (1988), on wheat plants, who found that drought decreased the tryptophan synthase alpha monomers was gradually dissociated from oligomers. This in turn produced less active isoenzymes. This reduced the biosynthesis of L-tryptophan and consequently that of IAA, so that plant growth was retarded or even stopped. These changes were reversible when growing conditions of the plant improved and the alpha 3 beta 4 oligomer was resynthesized. Similar results were obtained in the present results when the conditions were reversed by exogenously applied IAA.

However, the application of organic manures (either CKM or FYM) to poor sandy soil (El-Nubaria), either alone or in combination with IAA, resulted in a significant increase in plant growth compared with the control. These increments are greater in CKM than FYM. Similar results were obtained by Faiyed *et al*. (1991) who found that shoot dry weight increased in response to poultry manure application with a slight increase in the case of FYM.

In general, the improvement of plant growth in response to the organic manures application was due to the increase of soil organic compounds and consequently its fertility (Cassman *et al*. 1992).

Carbohydrate contents of the leaves: It is clear from figure 2 that IAA significantly increased the glucose and total soluble sugar contents of the cowpea leaves, but these increments were higher in response to IAA at a lower concentration (12.5 ppm) than at higher ones (25 and 50 ppm). In addition, 12.5 and 25 ppm IAA induced a highly significant increase in sucrose contents.

The presented results showed that total soluble sugars were increased in response to IAA treatments (Fig. 2). These results were similar to those obtained by Dogra *et al*. (1994), who stated that IAA increased the water soluble and acid soluble sugar contents of wheat. These increases were a response to the drought-induced water deficit, using osmotic adjustment to achieve the active accumulation of solutes within the cellular compartments of the plants, where this is usually followed by a reduction of the osmotic component of the water potential. This mechanism helps the cell to maintain turgor above the critical levels, preventing excessive water loss and the negative effects of drought on the physiological activity of the plant (Peltler & Marigo 1999; Rodriguez *et al*. 1999).

Concerning the effect of IAA on polysaccharides and total carbohydrates values of cowpea leaves, significant increases were seen. The maximum increase was achieved at the higher concentration (50 ppm IAA). These results showed that IAA induced a stimulatory effect on carbohydrate synthesis. Similar results were obtained by Hathout *et al*. (1993).

It is necessary to point out that drought causes a reduction in photosynthetic activity (Flexas *et al*. 1999). However, water stress is often accompanied, particularly under

Mediterranean conditions; by other limiting factors such as high temperature, a leaf-to-air vapour pressure deficit, nutrient depletion and irradiance. It has been demonstrated that the combination of these factors favours photoinhibition which limits the photosynthetic capacity of plants (Valladares & Pearcy 1997) and this was consequently reflected on the carbohydrates.

With regard to the plants grown in soil mixed with each type of organic manures, (either farmyard or chicken), total carbohydrate production was enhanced in the cowpea plants. This increase was due to an increase in glucose and total soluble sugars in FYM and polysaccharides in CKM.

This effect could be in relation to the increase of soil C/N ratio. The decomposition of organic matter also benefits plant nutrition by increasing the percentage of ambient carbon dioxide, some of which escapes into the atmosphere and is absorbed by plants through the stomata as a source of carbon (Othieno 1973).

The mixed application of different IAA concentrations and different types of organic manure induced variable increases in the total carbohydrates in cowpea leaves. This parameter reached the highest values in response to IAA (12.5 and 25 ppm) in the presence of CKM. This result was due to the increase in glucose, sucrose and total soluble sugars. Meanwhile, the polysaccharides were increased in response to 12.5 ppm IAA only and were still more or less constant at 25 and 50 ppm IAA. However, FYM induced a significant increase in total carbohydrates with increasing IAA concentration, which was due to the increase in polysaccharides and sucrose. Meanwhile, a reverse situation was observed in glucose and total soluble sugars.

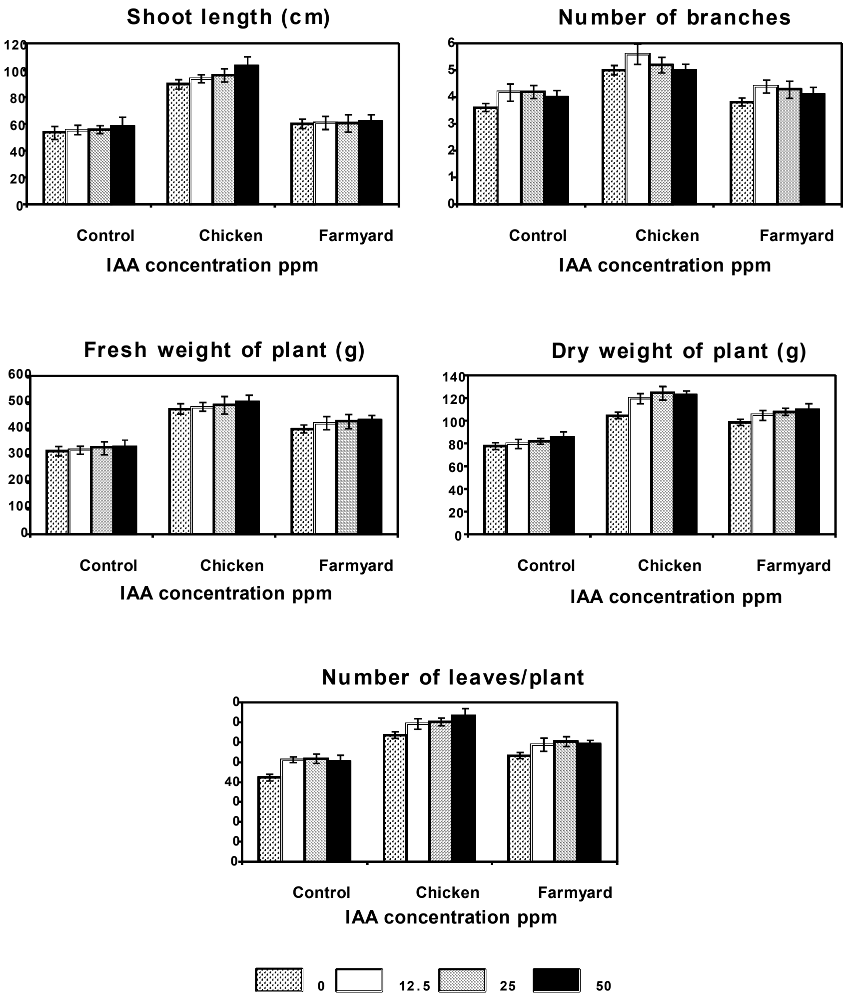


Fig. (1). The effect of the different concentrations of IAA and the different types of manure on growth measurements. Each value is the mean of 10 samples ± s.e.

Nitrogenous constituent in leaves: The results, as is clear in figure 3, indicate that the amounts of total soluble nitrogen, total nitrogen and protein nitrogen were significantly increased with increasing IAA concentrations. The increase in total soluble nitrogen may be due to the increase in amino acids as recorded by Shukry *et al*. (1990). The protein contents were increased by IAA treatments. These increments could be due to the direct increase of mRNA and protein synthesis (Singh *et al*. 1987). Moreover, Hathout *et al*. (1993) found that the protein content of tomato plants were increased significantly subsequent to foliar spray with 10 to 80 ppm IAA, particularly at the lower concentrations.

Supplemental application of FYM or CKM to the soil showed a higher values of total soluble nitrogen, protein nitrogen and total nitrogen in cowpea leaves. These increases were due to the highest value from the nitrogenous component of organic manure, which was added to the soil as recommended by Kumar *et al*. (1993); Maynard (1994) and Bvoungyeul *et al*. (1996) and consequently there was an increase in nitrogen uptake in maize plant (Grignani *et al*. 1994).

In addition, it was clear in Fig. 3 that, there were significant increase in nitrogenous constituent with increasing IAA concentrations in combination with organic manures.

Mineral contents: As presented in Fig. 4, K, Na and Ca showed increases in the leaves of cowpea in response to IAA treatments. These increases are in parallel with IAA concentrations. The results reflect the role of IAA in increasing the uptake and the translocation of the element solutes in the tissues of the leaves. This process is conducted to counter the harmful effect of the drought. Similar results were shown by Hathout *et al*. (1993) on tomato plants.

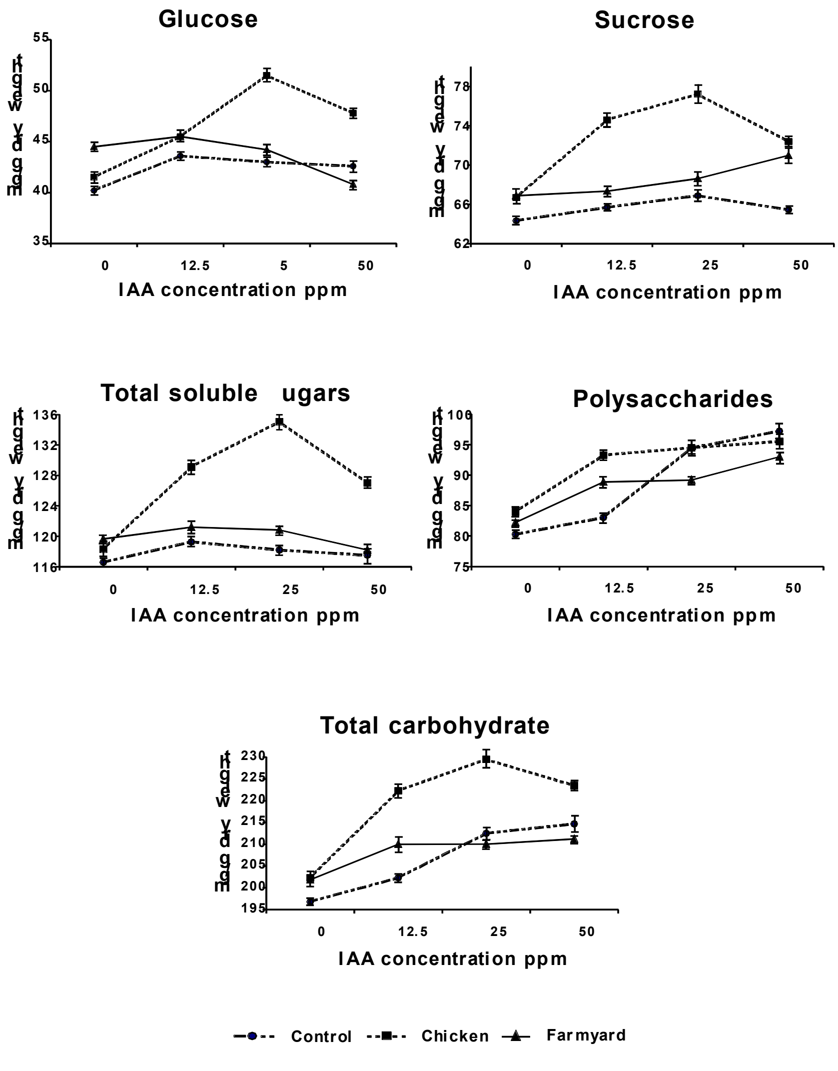


Fig. (2). The effect of the different concentrations of IAA and the different types of manure on the carbohydrate contents of Cowpea leaves as mg/g. dry weight. Each point is the mean of 4 samples ± s.e.

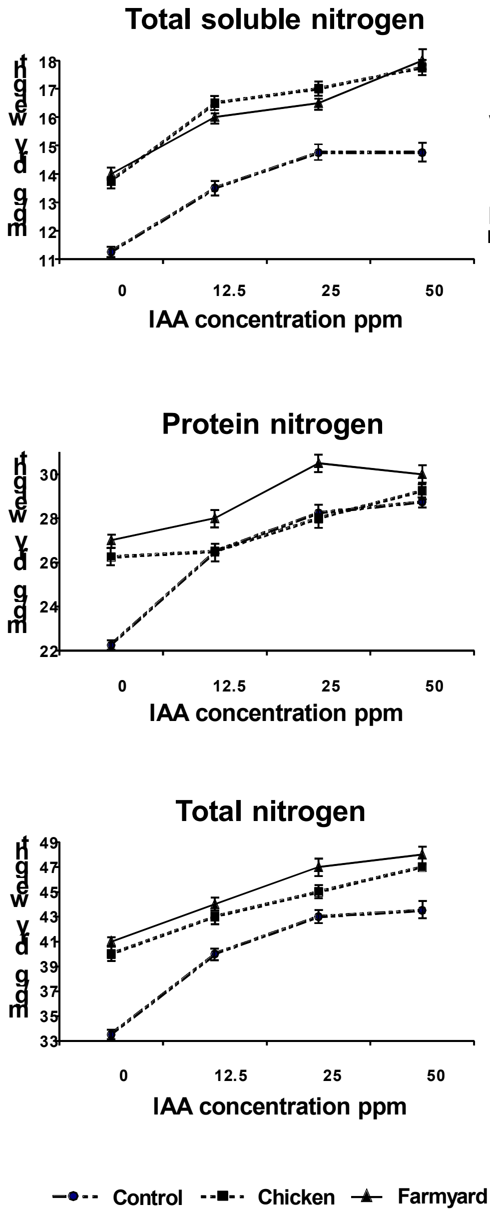
The growing of plants in a soil supplemented by organic manures (in absence of IAA) increased the ionic contents of leaves from K, Na and Ca. These results are in accordance with those obtained by Bvoungyeul *et al*. (1996), who found that, organic composts increased CEC (cation exchange capacity) of the soil. Bagavathimmal & Muthiath (1995) found that FYM increases K uptake by rice plants. The combined treatments between IAA concentrations and FYM or CKM generally induced a greater increase K, Na and Ca contents than each one of them when applied in the absence of the other. In Table 2, IAA increased the amount of Mg in cowpea leaves, to an amount in parallel with the increase in IAA concentrations (Hathout *et al*. 1993).

Table (2). Effect of IAA and organic manures on the ionic contents of cowpea leaves grown in Nubaria region as mM/g^{-1} D. Wt x 10^{-6}. Two-way analysis of variance were carried out.

Treatment	Mg	Zn	Fe	Mn	Cu	Pb	Ni
Control + 0.0 IAA	250.99	74.60	16.30	5.11	0.415	2.28	4.468
	±0.58	±0.58	±0.58	±0.58	±0.029	±0.03	±0.03
Control + 12.5 IAA	359.90	76.7	91.02	4.18	0.448	1.90	3.908
	±0.58	±0.58	±0.58	±0.58	±0.029	±0.03	±0.03
Control + 25.0 IAA	350.88	96.3	87.60	4.20	2.30	1.78	2.500
	±0.58	±0.58	±0.58	±0.58	±0.029	±0.03	±0.03
Control + 50.0 IAA	340.12	154.0	50.74	4.00	19.51	-	2.550
	±0.58	±0.58	±0.58	±0.58	±0.029		±0.03
F-Test	1.000	1.000	1.000	1.000	1.3129	0.9036	1.5429
P-Value	0.000	0.000	0.000	N.S.	0.000	0.000	0.000
Chicken manure + 0.0 IAA	297.43	123.1	30.41	12.472	2.21	3.341	4.672
	±0.58	±0.58	±0.58	±0.58	±0.50	±0.01	±0.00
Chicken manure + 12.5 IAA	408.95	120.4	198.13	7.506	3.49	1.265	-
	±0.58	±0.58	±0.58	±0.58	±0.50	±0.01	
Chicken manure + 25.0 IAA	998.11	143.9	223.5	4.333	4.64	1.110	-
	±0.58	±0.58	±0.58	±0.58	±0.50	±0.01	
Chicken manure + 50.0 IAA	345.8	132.9	54.98	3.988	3.82	0.332	-
	±0.58	±0.58	±0.58	±0.58	±0.50	±0.01	
F-Test	1.000	1.000	1.000	2.000	11.8581	0.4030	2.4545
P-Value	0.000	0.000	0.000	0.000	0.0034	0.000	0.000
Farmyard manure + 0.0 IAA	310.73	366.8	43.59	18.75	5.81	3.574	3.130
	±0.058	±0.58	±1.13	±0.58	±0.29	±0.01	±0.01
Farmyard manure + 12.5 IAA	409.33	271.1	199.50	16.298	1.08	2.310	3.440
	±0.058	±0.058	±1.13	±0.058	±0.29	±0.01	±0.01
Farmyard manure + 25.0 IAA	381.53	143.1	135.85	10.243	3.89	1.740	6.097
	±0.058	±0.058	±1.13	±0.058	±0.29	±0.01	±0.01
Farmyard manure + 50.0 IAA	368.85	161.3	92.87	13.136	4.31	1.561	-
	±0.058	±0.058	±1.13	±0.058	±0.29	±0.01	
F-Test	1.000	0.000	0.7538	1.000	0.6085	0.6364	0.2727
P-Value	0.000	0.000	0.000	0.0002	0.0002	0.000	0.000

N.S. : Non significant.

The combination of FYM or CKM with IAA concentrations significantly increased Mg contents in cowpea leaves, particularly 12.5 ppm IAA plus FYM and 25 ppm plus CKM. The same trend was recorded in the case of Zn and Fe. However, Mn, Pb and Ni were decreased with increasing IAA concentrations, either alone or combined with organic manure, where Ni was not detected in leaves in the presence of FYM at 50 ppm IAA and in the presence of CKM (12.5, 25 and 50 ppm IAA). In addition, Pb was not detected in response to 50 ppm IAA alone. Meanwhile, Cu concentrations were increased significantly in response to IAA concentrations. It is observed that the increase of Cu in the leaves was accompanied by an increase in K (Vardaka *et al*. 1997). In general, these results were in accordance with those obtained by Warman *et al*. (1993) and Suwara *et al*. (1994).



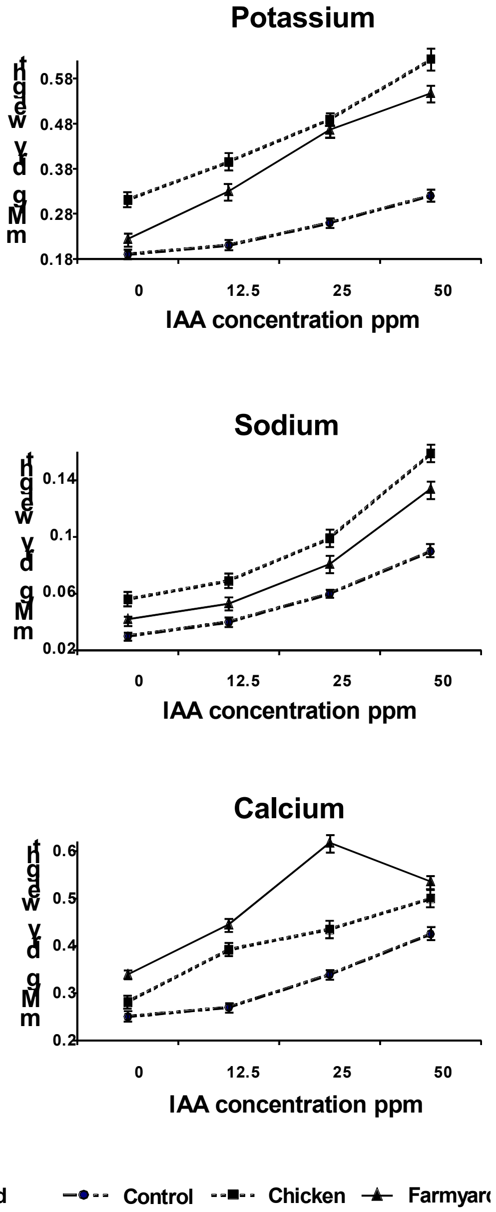


Fig. (3). The effect of the different concentrations of IAA and the different types of manure on nitrogenous constituents of Cowpea leaves as mg/g. dry weight. Each point is the mean of 4 samples ± s.e.

Fig. (4). The effect of the different concentrations of IAA and the different types of manure on K, Na & Ca contents of Cowpea leaves as mM/g. dry weight. Each point is the mean of 4 samples ± s.e.

A clear response to the higher mineralization of the soil due to the presence of FYM and/or CKM. Similar results were reported by different investigators (Abdel-Magid *et al*. 1995; Bibak 1994). Hsieh & Hsu (1993) also found that composted cattle manuure and chicken manure increased soil pH, OM, exchangeable K and Mg and extractable Mn, Zn and Cu and decreased soil salinity and extractable Fe. Soil concentrations of Na, Ni and Pb were slightly increased. Meanwhile, Mn, Ni, Cd and Pb were lower in the manure treated sweetcorn and soybeans than untreated ones.

Fig. 1 and Table 2 showed a clear relationship among all the organic fertilizers and the morphological characteristics of the cowpea plants, where micro nutrients and heavy metal contents of the plant leaves did not increase above the normal levels (Awad *et al*., 1993).

Yield and yield attributes: The results as presented in figure 5 showed an increase in the number of pods/plant, number of seeds/pod, number of seeds/plant, weight of pod/plant, weight of seeds/plant and weight of seeds/feddan in parallel with the increase in IAA concentration. This pattern of results was confirmed by several investigators where Raghuranula *et al.* (1990) found that spraying robusta coffee plants with 8 ppm IAA in drought conditions increased fruit retention due to the reduction in endogenous level of ABA which was induced by drought conditions. Similar result were obtained by Yadav *et al.* (1991), who showed an increase in the number of seeds in *Brassica juncea* and *Brassica tournefortii* plants sprayed by IAA was due to its resistance to drought. Moreover, Omer *et al.* (1997) found that foliar application of IAA increased seed yield of *Cumm cymumun* plants grown in sandy soil.

The results showed that the growth of cowpea plants using different organic manures (CKM or FYM) induced a highly significant increase in the yield and yield attributes as compared with the control. In support of the above mentioned results Wonprasaid *et al.* (1996) (rice) and Ramamurthy & Shivashankar (1996) (soybean) confirmed the illustrated pattern of results. Concerning the effects of CKM treatment, Mavriad (1994) found that the yield of tomatoes was increased with chicken manure as a sole source of nutrients rather than the other composts. Regarding the effects of FYM treatment, Anamika & Singh (1996) found that FYM gave higher yields or both seeds and sprouts than did inorganic fertilizers. Moreover, Kumar *et al.* (1993) found that seed yield in cowpea was increased with the application of FYM.

With respect to the IAA treatments in the presence of CKM or FYM, higher increases in cowpea yield and yield attributes were generally induced than the application of either of them alone.

Chemical analysis of seeds: IAA treatments significantly increased the carbohydrate contents of the yielded seeds (Fig. 6), which is paralleled with the increase in IAA concentration, either alone or in combination with CKM or FYM. This increase may be due to the increased rate of translocation of carbohydrate from pumb (leaves) to sink (seeds) (Ray & Choudhuri 1981).

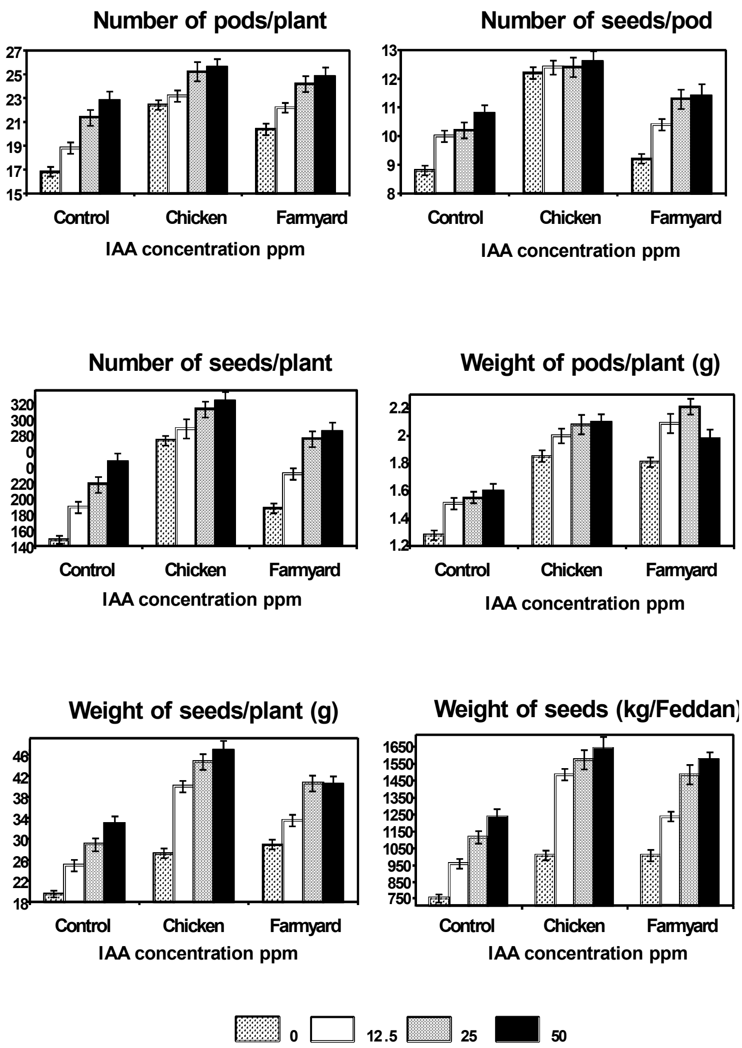


Fig. 5: The effect of the different concentrations of IAA and the different types of manure on yield components. Each value is the mean of 10 samples ± s.e.

The protein content of seeds was significantly increased at 12.5 ppm and then decreased at 25 and 50 ppm IAA and in combination with CKM. Meanwhile in FYM, there were significant increases at 12.5 and 25 ppm IAA and a decrease at 50 ppm (Fig. 6). These results support those obtained by Kumar *et al*. (1993) and Wonprasaid *et al*. (1996) who found that the nitrogen content of seeds was increased in the presence FYM. In general, seeds of farmyard manure has a good quality from either carbohydrate and protein with a special respect at 25 ppm IAA. The ionic contents of seeds are shown in Fig 6 and Table 3. K, Na and Ca showed a significant increase at IAA treatments and in combination with CKM or FYM. The same trend was recorded as in leaves. This was due to the translocation of these elements to the storage organs (seeds) throughout the xylem vessels.

Table (3). Effect of IAA and organic manures on the ionic contents of cowpea seeds grown in Nubaria region as mM/g^{-1} D. Wt x 10^{-6}. Two-way analysis of variance were carried out.

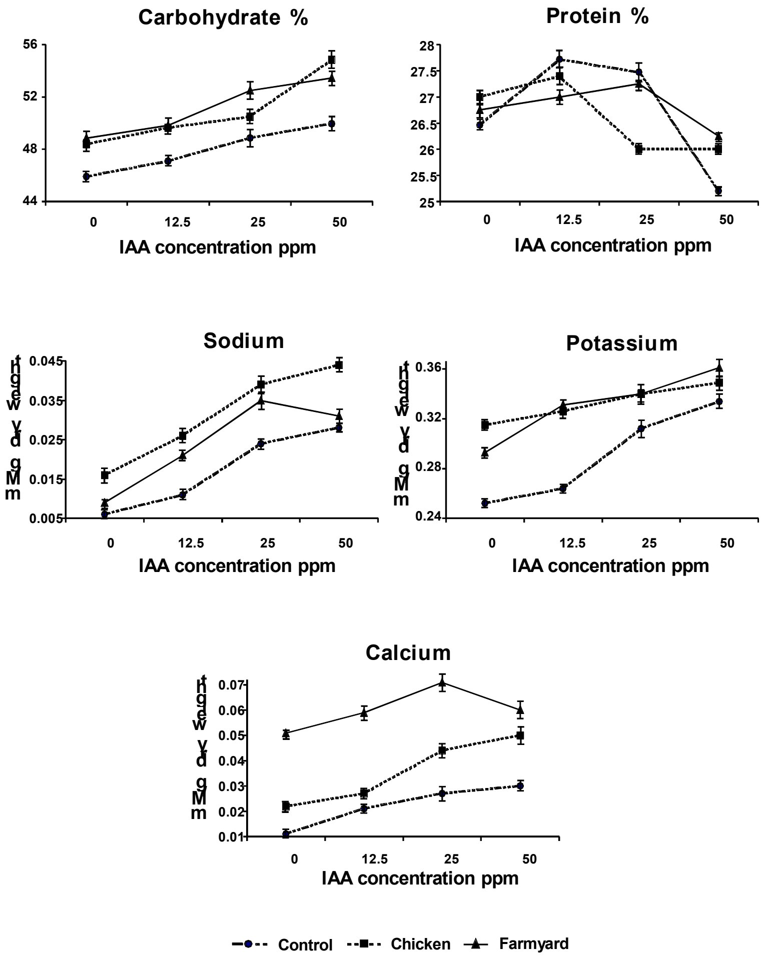
Treatment	Mg	Zn	Fe	Mn	Cu	Pb	Ni
Control + 0.0 IAA	195.6 ±0.14	15.3 ±1.53	6.181 ±0.06	0.224 ±0.04	0.815 ±0.03	0.372 ±0.01	1.165 ±0.01
Control + 12.5 IAA	200.84 ±0.14	23.03 ±1.53	6.55 ±0.06	1.697 ±0.04	0.91 ±0.03	0.753 ±0.01	1.92 ±0.01
Control + 25.0 IAA	226.39 ±0.14	35.30 ±1.53	7.169 ±0.06	1.243 ±0.04	1.10 ±0.03	0.433 ±0.01	1.811 ±0.01
Control + 50.0 IAA	293.99 ±0.14	13.2 ±1.53	11.37 ±0.06	0.923 ±0.04	0.48 ±0.03	0.333 ±0.01	1.743 ±0.01
F-Test	2.0768	1.1887	1.000	2.3595	1.5429	0.333	0.000
P-Value	0.000	0.0001	0.000	0.000	0.000	0.000	0.0013
Chicken manure + 0.0 IAA	224.71 ±0.06	33.00 ±0.06	6.37 ±0.06	2.234 ±0.05	0.730 ±0.03	0.332 ±0.01	0.93 ±0.01
Chicken manure + 12.5 IAA	290.72 ±0.06	17.50 ±0.06	10.49 ±0.06	1.823 ±0.05	0.531 ±0.03	0.194 ±0.01	0.677 ±0.01
Chicken manure + 25.0 IAA	348.50 ±0.06	23.78 ±0.06	14.23 ±0.06	1.138 ±0.05	1.854 ±0.03	0.129 ±0.01	-
Chicken manure + 50.0 IAA	825.45 ±0.06	14.40 ±0.06	26.81 ±0.06	0.9905 ±0.05	0.278 ±0.03	-	-
F-Test	4.500	3.500	1.000	6.9504	2.5789	9.000	2.4545
P-Value	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Farmyard manure + 0.0 IAA	242.05 ±0.06	13.00 ±0.06	8.61 ±0.06	1.549 ±0.04	0.669 ±0.01	0.370 ±0.01	0.723 ±0.01
Farmyard manure + 12.5 IAA	299.90 ±0.06	13.50 ±0.06	11.43 ±0.06	1.254 ±0.04	0.489 ±0.01	0.300 ±0.01	1.165 ±0.01
Farmyard manure + 25.0 IAA	458.74 ±0.06	31.70 ±0.06	15.92 ±0.06	1.891 ±0.04	0.716 ±0.01	-	-
Farmyard manure + 50.0 IAA	519.46 ±0.06	12.20 ±0.06	20.74 ±0.06	1.124 ±0.04	0.323 ±0.01	-	-
F-Test	0.000	1.000	2.333	1.6328	1.4211	2.4545	0.000
P-Value	0.000	0.000	0.000	0.000	0.000	0.000	0.000

In general, IAA at all concentrations increased all trace elements in the seeds. This trend differed in the case of combination with CKM or FYM, in the respect that Ni was not detected in seeds of CKM and FYM at concentrations of 25 and 50 ppm, Pb in FYM at 25 and 50 ppm IAA and in CKM at 50 ppm IAA. These trace elements that were not detected in leaves or in seeds may be accumulated and retained by the roots. However, Khadr *et al*. (1988) found that in the soil treated with chicken manure increases in N, P, K, Fe, Zn and Mn contents in wheat grain were observed.

Amino acids in seeds: The data presented in Table 4 show the effect of the used treatments on the total amino acid and the essential and non essential amino acids.

Regarding IAA effects, it is clear that its lowest concentration (12.5 ppm) increased the total amino acids while the reverse was shown in response to 50 ppm IAA.

Meanwhile, the addition of FYM alone decreased the amino acid contents but when combined with 12.5 and 25 ppm IAA induced a noticeable increase. However, CKM treatments with or without IAA their data showed no changes on the amino acid contents in comparison to the control. The data in Table 4 show that in general, IAA treatment, increased the ratio of the essential amino acids (histidin, arginine, threonine, valine, methionine, leucine, isoleucine, phenylalanine and lysine) to the non essential amino acids (aspartic, glutamic, serine, glycine, alanine, proline, tyrosine and cystiene) of the yielded seeds of cowpea plants. In this respect Narkumaraja *et al*. (1997) concluded that IAA induced changes in aminocylation levels and isoacceptor in ragi (*Eleusine corocane*) coleoptiles.



Overall amino acid acceptance was elevated following IAA treatments. In particular the relative acceptance activities for Ile, Leu, Lys, Phe, Ser and Tyr in IAA treated plants. Meanwhile, CKM treatment showed no effect regarding the ratio of essential and non-essential amino acids. FYM treatment induced a greater increase in the values regarding this ratio in the yielded seeds. The combination treatments of the different concentrations of IAA with CKM or FYM showed high increases with respect to the essential and non-essential amino acid ratio, where this result in turn will raise the protein value of the yielded seeds.

With regard to the proline amounts, which is the most important organic solute in the defense against drought (Pustovoitova *et al*. 2000), the data showed high increments in response to the different treatments of IAA in the presence and absence of CKM or FYM.

For the final conclusion, it was seemed that IAA can be used for overcoming the stress induced by drought and it can be used in combination with organic manures either chicken or farymard, to reclaim arid soils as in Nubaria region in Egypt.

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الملخص العربي

التأثير المتبادل لإندول حمض الخليك والمخصبات الحيوية على نمو وأيض وإنتاجية نبـات اللوبيـا تحت ظروف الجفاف

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تم زراعة نبات اللوبيا في أرض جافة في منطقة النوبارية وقد عوملت مجموعة من هذه النباتات بمخصبات عضـوية (مخلفـات الماشـية أو مخلفات الدجاج) ورشت مجموعة ثانية بإندول حمض الخليك [ثلاثة تركيزات (12.5 ، 25 ، 50 جزء في المليون)] بينما تم معاملة مجموعـة ثالثة بكل من المخصبات العضوية وأندول حمض الخليك وتركت مجموعة أخرى دون أي معاملات (مجموعة ضابطة). وقد أوضحت النتـائج أن مجموعة النباتات المرشوشة بإندول حمض الخليك دون إضافة مخصبات عضوية أظهرت زيادة في معايير النمو (الطول والوزن الغـض والوزن الجاف وعدد الأفرع وعدد الأوراق/نبات) بالإضافة إلى زيادة في إنتاجية المحصول (عدد القرون/نبات وعـدد البـذور/نبـات ووزن القرون/نبات ووزن البذور/نبات ووزن البذور/فدان) وذلك مقارنة بالنباتات غير المعاملة. وربما يرجع ذلك إلى التأثير الفعال لإندول حمـض الخليك في مقاومة الإجهاد الناشئ نتيجة العطش وذلك عن طريق زيادة تراكم الذوائب العضـوية (المـواد السـكرية – البـرولين – المـواد النيتروجينية) والذوائب غير العضوية (مثل عنصر البوتاسيوم – الكالسيوم – الصوديوم – الماغنسيوم – الزنك – الحديد – النحاس) في كلٍ مـن أوراق وبذور نبات اللوبيا. كما أوضحت النتائج أيضاً نقصاً في تركيز عناصر المنجنيز والرصاص والنيكـل. وقـد أدى اسـتخدام الأسـمدة العضوية منفردة إلى زيادة كبيرة في غالب القياسات السابق ذكرها مقارنة بالنباتات غير المعاملة (الضابطة) وأيضاً بالنباتات المرشوشة بإندول حمض الخليك.

كما أظهرت النتائج المتحصل عليها أن معاملة نبات اللوبيا بالمخصبات العضوية مصحوبة بالرش بإندول حمض الخليك أدى إلى زيادة معنوية واضحة في معايير النمو وإنتاجية النبات مقارنة بأي معاملة أخرى.