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Improving the Production of Well Irrigated Cauliflower (*Brassica Oleracea* L. *Var. Botrytis*, Cv. Snowball Y. Imp) by Foliar Spraying of some Growth Regulators.

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Abstract

Three different experiment were conducted on Snowball Y. IMP Cauliflower Cultivar. Seeds were sown in seedbed to produce transplants. The obtained transplants were planted on furrows, and then they were sprayed twice, 2 weeks after transplanting and 4 months latter with either gibberellic acid (GA_3) at rates of 0.0, 20, 30 and 40mg.l^{-1}, indole-3-butyric acid (IBA) at rates of 0.0, 20, 30 and 40mg.l^{-1}, or naphthalene acetic acid (NAA) at rates of 0.0, 20, 30 and 40mg.l^{-1} to improve the production of snowball Y. IMP cauliflower cultivar which was irrigated whenever 25% of soil water capacity is depleted to a soil depth of 30cm. The results revealed that snowball Y. IMP cauliflower cultivar required supplementary irrigation of 327.6 mm, besides 254.3 mm rainfalls, during the entire growing season. GA_3 application substantially increased the yield of cauliflower particularly 40 mg.l^{-1} which gave the highest yield (3.65 kg.m^{-2}), as compared to check (2.44 kg.m^{-2}). Regression analysis displayed that cauliflower yield responses to GA_3 application could be estimated by the following positive linear equation (Yield kg.m^{-2} = 2.35836 + 0.0313786(GA3rate)). IBA application substantially increased the yield of cauliflower particularly 40 mg.l^{-1} which gave the highest yield (7.61 kg.m^{-2}) as compared to untreated control (5.74 kg.m^{-2}). Regression analysis displayed that cauliflower yield responses to IBA application could be estimated by the following cubic equation (Yield kg.m^{-2} = 5.7375 + 0.599098(IBA rate) - 0.0436278(IBA rate)^{**2} + 0.0007442(IBA rate)^{**3}). NAA application substantially increased the yield of cauliflower particularly 30 mg.l^{-1} which gave the highest yield (3.15 kg.m^{-2}) as compared to check (1.4 kg.m^{-2}). Regression analysis displayed that cabbage yield responses to NAA application could be estimated by the following positive linear equation (Yield kg.m^{-2} = 1.85084 + 0.0377673(NAA rate).

Keywords: Irrigation, IBA, GA_3, Cauliflower, Growth Regulators.

Introduction

Cauliflower is belong to *Brassica oleracea* L. var. botrytis and is a biennial cool season vegetable crops [1]. Some cauliflower cultivars have a short juvenile period and can be induced to flower by 1 to 2 weeks of low temperature [2]. Summer cauliflower varieties grown in the Pacific Northwest are intermediate types. They do not need cool weather to initiate curd formation, but will respond to a cool period by initiating curds after they have reached the mature vegetative phase. As snowball types grow through the juvenile's stage and reach the mature vegetative phase, curd initiation may be delayed by extending hot weather above 26.66^{0}C. After reaching the mature vegetative stage, they also may be prematurely triggered into initiating curd formation by a period of cool 10 to 15.56^{0}C. These characteristics can cause harvest scheduling problems [3].

Cell division can contribute to growth only by producing more cells which can undergo developments. There is evidence that GA affects the processes of cell division in higher plants and it does so in two ways. In the sub-apical region of both rosette and calescent plants, GA_3 increases the size of meristematic

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region and increases the proportion of cells which are undergoing division.

These effects of GA_3 on cell division can be rapidly accounted for by an effect on cell cycle [4,5] has proposed that one of the effects of GA_3 on cell division is to promote the onset of DNA synthesis in cell which are arrested in the G! phase of the cell cycle. Gibberellic acid (GA_3) significantly increased β-1,3-Glucanase, α-Amylase, α-Glycosidase, acid phosphatase, Pectinase, Phytase, Lipase, Invertase, RNAase, Peroxidase, Esterase, Nuclease. Thus, this study was conducted to investigate the improvements in the production of snowball Y. IMP cauliflower cultivar that may be gained from spraying gibberellic acid (GA_3).

Auxins play major role in plant growth and developments, as it improve cell division, cell elongation and enhance cellular membrane performance. [6] found that, the production of xylem strands at the base of petiole is directly proportional to the stream of diffusible IAA moving through the petiole. Defoliation of *Coleus* epicotyls strongly reduces xylem differentiation, but this effect can be removed by applying equivalent amounts of IAA in lanolin paste. Endogenous auxin content of intact tissue is high enough to support maximum elongation and added auxin has little or no additional effect. Recent studies confirmed that IBA is endogenously synthesized. [7]. Found that IBA is an endogenous auxin in maize. Moreover IBA is converted to IAA in plant tissues. [8] found that developmental defects in the absence of exogenous sucrose suggest that some of these mutants are impaired in proximal fatty acid chain shortening, implying that the conversion of IBA to IAA is also disrupted. The actions of IBA or auxin were attributed to the regulation of plant development by producing the senescence hormone ethylene or by binding protein. [9] reported that the localization of auxin-binding protein (*ABP1*) has caused a great deal of debate, as the majority of *ABP1* has been found with in endoplasmic reticulum (as would be expected to residue on the plasma membrane. Indeed, a number of studies have indicated that a portion of the *ABP1* pool is localized to the plasma membrane, where it is involved in an auxin-mediated membrane hyper polarization response. *ABP1* is assumed to either bind to plasma membrane docking protein or directly interact with an ion channel (s). Thus, it is a general that, the effect of exogenously supplied auxin can be demonstrated only in tissues, such excised segments of stems and coleoptiles that have been removed from the normal auxin supply. They also reviewed that, this sub rule may be subject to change, however, since a sustained growth of intact pea internodes following exogenous applications of IAA [10]. Therefore, the objective of this study was to examine the ability of naphthalene acetic acid in improving the production performance of well irrigated snowball Y. IMP cauliflower cultivar.

Materials and Methods

Three separate experiments were carried out during 2005-2006 growing season at the research field of Horticulture Department, Mosul Univ., Northern Iraqi province (36^0, 42” Latitude) to investigate the possibility of improving the production of Snowball Y. IMP cauliflower cultivar by the separate foliar application of gibberellic acid (GA_3), indole-3-butyric acid (IBA) and naphthalene acetic acid (NAA) at rates of (0.0, 20, 30 and 40mg.l^{-1}), respectively, in experiment 1, 2 and 3. Snowball Y. IMP cauliflower cultivar seeds were purchased from the agricultural office. This cultivar was produced by Modesto seeds Producer Company, USA, under lot no. 337-291-59, germination percentage 85% and test date was on February, 2002. A Randomized Complete Block Design (RCBD) was chosen for each of the three experiments to include four rates 0.0, 20, 30 and 40mg.l^{-1}. Each treatment was replicated five times, and each replicate was represented by a furrow of (0.8 x 5m) planted on one side with a plant space of 35cm.

Soil was analyzed at the Soil and Water Department Laboratory (Table, 1), while Meteorological data was obtained from Al-Rashidia Meteorological Station, Mosul (Table, 2). Soil was plowed twice then dissected to match the chosen design. gypsum blocks were settled at a depth of 30cm from each furrow top to truck the fluctuations of soil moisture content caused by supplementary irrigations and rainfall incidences [11]. Thus, precise time for irrigation was detected. Seedbed of 2m^2 was prepared and provided with 3 gypsum blocks settled at depth of 25cm, then fertilized by Diamino phosphate (DAP) at 20g.m^{-2} rate. On August 5$^{th.}$ 2005, seeds were sown in rows of 20cm apart. Transplants were planted in the permanent field on September, 15$^{th.}$ 2005. Weeds were manually controlled and Diamino phosphate (DAP) was broadcasted twice on October, 2$^{nd.}$ 2005 after weed eradication and once more on February, 10$^{th.}$ 2006. Plants were sprayed with GA_3, IBA and NAA on October, 5th. 2005 and repeated on February 7$^{th.}$ 2006. Plants were sprayed with benomyl fungicide at rate 1g.l^{-1}as protective spray on October, 20$^{th.}$ 2005. Finally plants were harvested on March, 26$^{th.}$ 2006.

Plants were brought to the laboratory, number of leaves per plant was counted whereas plant height, stem length and curd circumference were measured. Fresh weight of produced curd per m^2, leaves, stem, root, curd and entire plant were weighed by electrical balances. A hand refrectometer was used to determine the total soluble solids (TSS) of curd. Samples of leaves, root, stem and curd were weighed and then oven-dried at 60^{0}C for 72 hours. Thereafter their dry weights were recorded to calculate their dry matter percentages.

Table (1). Physical analysis for upper 30 cm translocated silty loam soil and clayey underneath field native soil

Soil separations (g.kg^{-1})	Translocated soil	Field native soil
Clay particles	564	139
Silt particles	313	564
Sand particles	123	297
Soil bulk density (g.cm^{-3})	1.6	1.55
Soil field capacity (%)	21.8	20
Soil wilting point (%)	12.05	11

Table (2): Meteorological data, irrigation frequencies and applied water (mm) for cauliflower

Recorded parameters	Growing season months							
	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Maximum temp. (^{0}C)	43.20	38.10	30.20	21.70	18.50	11.91	15.38	21.50
Minimum temp.(^{0}C)	25.7	19.8	13.60	7.30	6.40	3.64	6.22	7.75
Mean temp.(^{0}C)	34.45	28.95	21.90	14.50	11.95	7.60	10.80	14.63
Relative humidity (%)	31.00	34.00	65.00	57.00	67.00	78.36	71.10	38.95
Rainfall (mm)	0.0	0.0	0.0	20.60	40.20	142.70	50.80	1.40
Irrigation frequencies	4.00	8.00	6.00	4.00	3.00	0.00	2.00	1.00
Free vapor at. (mm.d^{-1})	16.71	11.5	6.19	3.39	2.1	1.14	1.79	3.16
Actual sunshine (H.d^{-1})	12	10.8	8.41	6.50	4.90	4.98	6.32	7.27

Results and Discussion

Effect of supplementary irrigation

The obtained results (figure, 1) revealed that cauliflower seedbed was irrigated with 87.75mm during the period from sowing to transplanting at the permanent field. Most of the consumed water was lost by evaporation rather than transpiration owing to the prevailing high temperature and poor vegetation coverage of soil. Gross complementary irrigation during the entire growing season was 327.6 mm, besides 254.3 mm rainfalls. 4, 8, 6, 4,. 3, 2, and 1 times of supplementary irrigation were practiced during August, September, October, November, December, February, and March respectively. However, adequate rainfall incidences were occurred during January (table, 2). Cauliflower is very water scarcity susceptible crop. Since drought is usually accompanied by curd defects. Blindness is the loss of growing point which associated with low temperature, moisture stress, molybdenum deficiency (Whiptail), day length, light intensity and insect damage [12]. Bottoming is most likely to be caused by conditions restricting vegetative growth such as low soil moisture, frost bird damage, poor soil structure, shortage of nitrogen and soil salinity. They showed that removal of young curds resulted in a 37% increase in the area of expanding leaves [13]. Cauliflower is a very demanding in terms of water and fertility requirements [14]. However, heavy irrigation is harmful. [15] reported that broccoli and cauliflower show hollow areas in the stem extending from below the head or curd to where the stem is normally cut. This disorder has been shown to be most severe when individual plants could grow rapidly such as: adequate moisture supply, warm weather, high nitrogen fertilizer levels and wide spacing. Cauliflower requires 304.8 to 381 mm of water depending on planting date, seasonal variation, variety and number of time the field is harvested. Soil type does not affect the water applied per application. Subtle irrigation is of significance in cauliflower watering to ensue well performance and to avoid disease infection and physiological disorders. After stand has been established provide uniform moisture throughout the growth of the crop. Do not over-water in the first 2.3 weeks after transplanting, or 4-5 weeks after direct seeding, especially if club root is suspected. However, any moisture stress, particularly when cauliflower reaches the 6-7 leaf stage, may cause cauliflower to button or form heads prematurely, such heads will be to small for market and are usually yellow due to inadequate leaf cover [3].

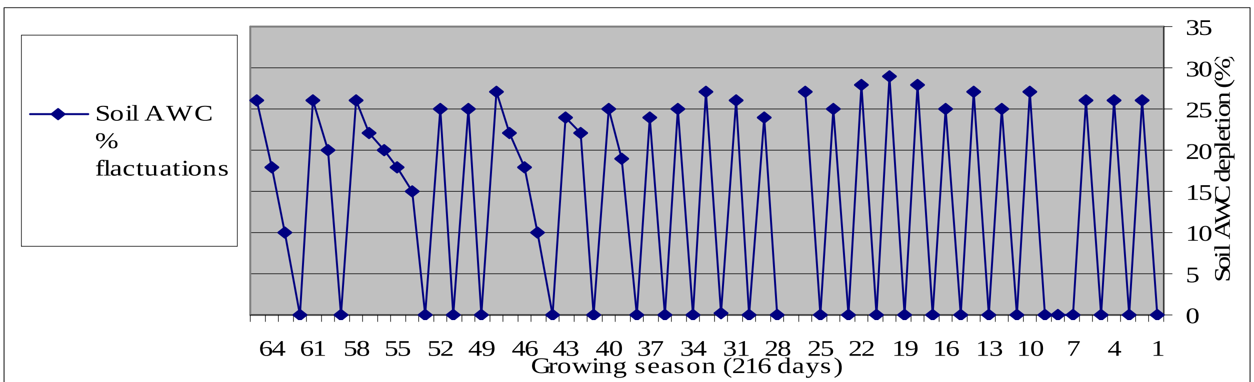

Figure (1): Soil moisture fluctuation fo rcauliflower irrigated whenever 25% of soil AWC is depleted to a soil depth of 30cm.

Effect of GA_3 on plant height

Snowball plants treated with 30ng.l^{-1} GA_3 displayed the highest plant height (70.13 cm) and highly exceeded other treatments. However, significant differences were not detected in other GA_3 rates including the untreated check (table, 3). Regression results manifested that at low GA_3 rates beyond zero experienced apparent reductions until they reach 8mg.l^{-1} GA_3 which coincided to lowest plant height then plant highest started to rise to extreme case of dwarfism in which the absence of any significant internodes elongation result in a compact growth habit characterized by closely spaced leaves. The failure of internodes to elongate may result from a genetic mutation, or may be environmentally induced. Regardless of the cause, hyperelongation of stem in rosette plants is invariably brought about by the application of small amounts of gibberellins.

Effect of GA_3 on fresh weight of leaves per plant

Cauliflower plants treated with 30ng.l^{-1} GA_3 (table, 3) displayed the highest fresh weight of leaves per plant (2350 g). It highly exceeded other treatments. However, significant differences were not detected in other GA_3 rates including the untreated check. Regression results manifested that at low GA_3 rates beyond zero, leaves fresh weight experienced apparent reductions till they reach 7.5mg.l^{-1} GA_3 which accompanied to lowest fresh weight of leaves per plant then it rise to attain its maximum level at 34mg.l^{-1} GA_3 thereafter phase of leaves fresh weight reductions was observed. Thus leaves fresh weight was cubically responded to varying GA_3 treatments, and this response could be estimated by the following equation: (fresh weight of leaves per plant g = 1125 – 202.917(GA_3 rate) + 17.15(GA_3 rate)^{**2} – 0.300833(GA_3 rate)^{**3}). Fresh weight of leaves attain its maximum level at 33mg.l^{-1} GA_3 thereafter phase of plant height reductions was observed. Thus plant height was cubically responded to varying GA_3 treatments, and this response could be estimated by the following equation: (plant height cm = 55.625 – 2.12292(GA_3 rate) + 0.183125(GA_3 rate)^{**2} – 0.0032083(GA_3 rate)^{**3}). [16] reported that, additional support for the role of gibberellins in stem elongation comes from the study of rosette plants. A rosette is essentially an per plant is a victor of leaves numbers, leaf expanding and their carbohydrate accumulation. Thus high fresh weight is a result of the role of gibberellins-like substance on growth and development of leaves [16]. Cauliflower plants go through a juvenile stage during which curd initiation does not occur, and can not be initiated. The end of juvenility period depends on variety, and appears to be correlated with the development of a minimum number of leaves, generally 6 to 8 expanded leaves or 35 to 50 differentiated leaves, depending on temperature; range can be much greater under certain condition [3].

Effect of GA_3 on leaves number per plant

Plants of snowball treated with 40 and 30ng.l^{-1} GA_3 rates displayed the highest number of leaves per plant (35 and 32, respectively). They highly exceeded other treatments. However, significant differences were not detected in 20mg.l^{-1} GA_3 rate and untreated check (table, 3). Regression results manifested that at low GA_3 rates beyond zero experienced apparent reductions in number of leaves per plant till they reach 9mg.$l^{-1}$$GA_3$ rate which accompanied to lowest number of leaves per plant then it rise to attain its maximum level at 34mg.l^{-1} GA_3 rate thereafter phase of number of leaves per plant reductions was observed. Thus leaves number per plant was cubically responded to varying GA_3 treatments, and this response could be estimated by the following equation: (number of leaves per plant = 27.75 – 1.79271(GA_3 rate) + 0.128594(GA_3 rate)^{**2} – 0.002026(GA_3 rate)^{**3}). [17] failed to reduce leaf numbers or significantly hasten curd formation by applying GA_3 to winter cauliflower. [18] found that in cauliflower, leaf number below the curd varied from 21 to 98 among a range of genotype. This may reflect differences in the end of the juvenile period.

Effect of GA_3 on dry matter accumulation in leaves

Significant differences were not found in the response of dry matter accumulation in leaves (table, 3). Regression analysis revealed that a percentage of leaves dry matter reductions stage confined with GA_3 from 0 to 20 mg.l^{-1} then GA_3 rates from 20 to 40 mg.l^{-1} revealed step by step leaves dry matter percentages increases. Therefore dry matter percentage of leaves is governed by the following quadratic equation: (dry matter percentage of leaves = 10.0324 – 0.145369(GA_3 rate) + 0.0033892(GA_3 rate)^{**2}).

Effect of GA_3 on individual stem fresh weight

Spraying plants of snowball cultivar with 30mg.l^{-1} GA_3 rate significantly increased stem fresh weight (283.75 g), as compared to 40mg.l^{-1} GA_3 (137 g), 20mg.l^{-1} GA_3 (164.15 g) and untreated check (156.96 g). However, non-significant differences were detected among the three latter rates (table, 3). The responses of stem fresh weight to different GA_3 concentrations exhibited three phases: (i). Rates from 0 to 8mgl^{-1} and (iii). Rates from 32 to 40mg.l^{-1} revealed step by step stem fresh weight reductions; in contrast rates from 8 to 32mg.l^{-1} showed stem fresh weight gradual increases efficacies. Therefore, stem fresh weight response to varying GA_3 application is ruled by the following cubic equation: (stem fresh weight g = 156.955 – 21.1501(GA_3 rate) + 1.63471 (GA_3 rate)^{**2} – 0.0279606(GA_3 rate)^{**3}). This fluctuation in the influence of GA_3 on stem fresh weight might be referred to the conversions of gibberellins to different active and inactive forms. Rosette plants of spinach contain high levels of inactive form GA_{19} and low levels of the active form GA_{20} [19,20] confirmed that, gibberellins are limiting factor in the stem growth of rosette plants and the effect of long days or cold treatment is to remove that limitation. In spinach and *Silene armeria,* both photoperiodic plants requiring long day to flower. Spinach contains six gibberellins including GA_{19} and GA_{20}. GA_{20} will cause bolting in spinach under short day conditions, while, GA_{19} is biologically inactive.

Effect of GA_3 on dry matter accumulation in stem

Application of GA_3 (table,3) on cauliflower plants at rate of 30mg.l^{-1} profoundly increased dry matter percentage of stem (26.29%), as compared to 40mg.l^{-1} rate (20.64%) and untreated check (20.65). Non-significant differences were detected neither between 30 and 20mg.l^{-1} nor among rates other than 30mg.l^{-1} rate. Stem dry matter percentages revealed reduction at low GA_3 rates until they exhibited the lowest magnitude at 8mg.l^{-1}, however, at rates beyond 8mg.l^{-1} stem dry matter percentages were gradually increased to attain the highest value at the most effective rate 30mg.l^{-1} thereafter at rates higher than 30mg.l^{-1} dry matter percentage resumed to decline step by step. Stem dry matter percentage response to varying GA_3 rates is ruled by the following cubic equation: (stem dry matter percentage = 20.65 – 1.01677(GA_3 rate) + 0.0843906 (GA_3 rate)^{**2} – 0.0014745(GA_3 rate)^{**3}). GA_3 application facilitates carbohydrate accumulation through regulating the engaged enzymes. [21] observed that gibberellic acid increased secretion of soluble carbohydrate, some of which appears to be glucan containing some β-1,3 linkages. This was followed by increased oxygen consumption and increased secretion of ATPase, GTPase phytase, phosphomonoestrase, phosphodiesterase, inorganic phosphate, carbohydrates other than amylase, Peroxidase and amylase.

Effect of GA_3 on stem length

Non- significant differences were detected in the response of stem length to different GA_3 rates (table,3). Stem lengths revealed reduction at low GA_3 rates until they exhibited the lowest magnitude at 9mg.l^{-1}, however, at rates beyond 9mg.l^{-1} stem lengths were gradually increased to attain the highest value at the most effective rate 33mg.l^{-1} thereafter at rates higher than 33mg.l^{-1} stem lengths resumed to decline step by step. Stem length response to varying GA_3 rates is dominated by the following cubic equation: (stem lengths cm = 13.15 – 0.65875(GA_3 rate) + 0.0480625 (GA_3 rate) ^{**2} – 0.0007813(GA_3 rate) ^{**3}). Gibberellins are made in a wide variety of plant organs (leaves, root and embryos), move through the plant vascular system, and are involved in regulating plant height. Dwarf plants have lower levels of gibberellins and plants with long, pale stems tend to have overproduction of gibberellins. Plants that bolt in fall (sudden stem lengthening) are being affected by gibberellins as are flowering, fertilization, seed production and growth of fruits, new leaves and branches. Gibberellins move upward and downward in plant vascular systems and stimulate stem lengthening and young branches [9]

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Effect of GA_3 on root fresh weight

Spraying snowball cauliflower cultivar by GA_3 rate of 30mg.l^{-1} (147.87 g) substantially exceeded 40mg.l^{-1} rate (69.6 g), 20mg.l^{-1} (81.15 g) and untreated control (96.95 g), in term of individual root fresh weight. However, significant differences were not recorded among GA_3 rates other than 30mg.l^{-1} rate (table, 3). Responses of root fresh weight were categorized to three kinds; firstly low rates of applied GA_3 sloped down the root fresh weight, where the worst rate was 10mg.l^{-1}.Secondly moderate rates showed tendency to recover these reductions, where 30mg.l^{-1} was the most effective rate. Thirdly resumption of reduction which accompanied rates higher than 30mg.l^{-1}. Subsequently the influence of varying GA_3 rates on root fresh weight could be forecasted by the following cubic equation: (individual root fresh weight g = 96.95 – 20.3646(GA_3 rate) + 1.45644 (GA_3 rate) ^{**2} – 0.0243354(GA_3 rate) ^{**3}). Root organogenesis is highly dependant on the number of cells that available to undergo growth and differentiation in which these processes. These cells are profoundly promoted by gibberellins-like substances. Cell division can contribute to growth only by producing more cells which can undergo developments. There is evidence that GA affects the processes of cell division in higher plants and it does so in two ways. In the sub-apical region of both rosette and caulescent plants, GA_3 increases the size of meristematic region and increases the proportion of cells which are undergoing division. These effects of GA_3 on cell division can be rapidly accounted for by an effect on cell cycle [4].

Effect of GA3 on dry matter accumulation in root

Snowball plants treated with GA_3 rates showed substantial reductions in root dry matter percentages, as compared to check (table, 3). Regression analysis manifested that the response of root dry matter percentage was linearly correlate to varying GA_3 rates and this response could be estimated by the following negative linear equation: (root dry matter percentage (24.9779 – 0.0970714(GA_3 rate)).

These results might be due to the competition between vegetative parts and root system over assimilate in which gibberellins alter the balance for the favour of leaves and curds developments.

Effect of GA3 on total soluble solids (TSS) of curd

Spraying cauliflower plants by GA_3 rate of 20mg.l^{-1} significantly increased curd TSS (6.19%), as compared to 30mg.l^{-1} (5.69%), 40mg.l^{-1} (5.5%) and control (5.44%). However, non-significant differences were found among the latter three rates (table,3). Regression results revealed that curd TSS was increased at rates from 0.0 to 20mg.l^{-1} then declined and the response of this parameter to varying GA_3 rates could be estimated by the next quadratic equation: (curd TSS % = 5.46193 + 0.0587784(GA_3 rate) – 0.0014915(GA_3 rate)^{**2}). Activates occur in curd are entirely achieved under intensive care of hormonal cocktail. [22] stated that, it has long been conjectured that the induction of cauliflower curd formation could be mediated by growth hormones, but attempt to substantiate this through direct measurement of endogenous compounds have only partly succeeded. The most consistent link between curd induction and hormone levels has been made for the gibberellins.

Effect of GA_3 on curd circumference

Non-significant differences were detected in the influence of GA_3 rates on curd circumference (table, 3). Regression results exhibited that curd circumference was linearly responded to GA_3 rates and this response could be estimated by the following positive linear equation: (curd circumference cm = 55.6671 + 0.122571(GA_3 rat)). [23] found that, application of the growth retardants ancymidol, chloromequat or daminozide to vegetative plants had no effects on curd diameter.

Effect of GA_3 on curd fresh weight

Spraying 30 and 40 mg.l^{-1} GA_3 rates (table, 3) significantly increased curd fresh weigh (775 and 844 g, respectively), as compared to 20mg.l^{-1} rate (469.4 g). However, non-significant differences were detected neither between the two highest rates and untreated nor between 20mg.l^{-1} and untreated as well. Regression results revealed that curd fresh weight response was linearly correlated to different GA_3 concentrations and it could be predicted by the following positive linear equation: (curd fresh weight g = 490.525 + 7.6725(GA_3 rate)). Improving curd fresh weight might be referred to the actions of gibberellins on protein and nucleic acid synthesis. GA_3 and ABA may affect the synthesis of mRNAs or proteins, at some stages or increase membrane permeability leading to the release of the performed enzymes [23,24] found in an extensive series of field planting that GA_{4+7} (a mixture of gibberellins (4 and 7), but not GA_3, applied when the plants had just reached the adult vegetative stage, reduced the number of leaves to the curd.

Effect of GA_3 on curd dry matter percentage

Significant differences were not found regarding the effect of varying GA_3 on dry matter percentage of curd (table, 3). Curd dry matter percentage reduction at low GA_3 rates until they exhibited the lowest magnitude at 11mg.l^{-1}, however, at rates beyond 11mg.l^{-1} curd dry matter percentages were gradually increased to attain the highest value at the most effective rate 35mg.l^{-1} thereafter at rates higher than 35mg.l^{-1} curd dry matter percentage resumed to decline step by step. Curd dry matter percentage response to varying GA_3 rates is governed by the following cubic equation: (Curd dry matter percentage = 9.175 – 0.372708(GA_3 rate) + 0.023125(GA_3 rate)^{**2} – 0.0003479(GA_3 rate)^{**3}).

Effect of GA_3 on marketable yield of curd: Spraying cauliflower plants by GA_3 rate of 40mg.l^{-1} substantially increased the curd marketable yield (3.65 kg.m^{-2}), as compared to untreated control (2.44 kg.m^{-2}). However, non-significant differences were not found among GA_3 rates other than 40mg.l^{-1} rate (table, 3). Regression analysis revealed that curd yield is linearly responded to varying GA_3 concentrations and it could be estimated by the following linear equation: (marketable curd yield kg.m^{-2} = 2.35836 + 0.0313786(GA^3 rate)). Yield increases gained by the application of GA_3 could be attributed to the role of gibberellins in cell division, cell elongation, cellular membrane modulation and protein synthesis. Effect of GA_3 on cell division is to promote the onset of DNA synthesis in cell which are arrested in the *G1* phase of the cell cycle [5]. [25] found that simultaneous application of IAA and GA_1 evoked continuous release of ethylene for at least 48 h after treatment and the yield of ethylene was the sum of amounts produced separately by IAA and GA_1. IAA had no effect on GA_1-induced elongation in open vials, but reduced the elongation in closed tubers, an effect undoubtedly associated with increased ethylene production. Gibberellic acid increased secretion of soluble carbohydrate, some of which appears to be glucan containing some β-1,3 linkages. This was followed by increased oxygen consumption and increased secretion of ATPase, GTPase phytase, phosphomonoestrase, phosphodiesterase, inorganic phosphate, carbohydrates other than amylase, Peroxidase and amylase [21].

Table (3): The effect of GA; on growth an yield of well irrigated snowball cauliflower cv.

Detected Parameters	GA3 mg.l^{-1}				Means
	0.0	20	30	40	
Plant height (cm)	55.63b	60.75b	70.13a	58.38b	61.22
Leaf fresh weights/ plant (g)	1125.00b	1520.00b	2350.00a	1195.00b	1547.5
Leaf numbers / plant	27.75b	27.13b	35.00a	32.13a	30.5
Leaf dry matter (%)	10.04a	8.45a	8.76a	9.63a	9.22
Stem fresh weight/ plant (g)	156.96b	164.15b	238.75a	137.00b	174.22
Stem dry matter (%)	20.65b	22.28ab	26.29a	20.64b	22.47
Stem length (cm)	13.15a	12.95a	15.55a	13.70a	13.84
Root fresh weight/ plant (g)	96.95b	81.15b	147.85a	69.60b	98.96
Root dry matter (%)	25.54a	22.24b	21.98b	21.43b	22.8
Curd total soluble solid (%)	5.44b	6.19a	5.69ab	5.50b	5.71
Curd circumference (cm)	56.08a	56.95a	60.10a	60.63a	58.44
Curd fresh weight (g)	564.30ab	469.40b	775.00a	844.00a	663.18
Curd dry matter (%)	9.18a	8.19a	9.41a	9.00a	8.95
Curd yield (kg.m^{-2})	2.44b	2.79ab	3.38ab	3.65a	3.07

Effect of IBA on plant height

The obtained results manifested that spraying cauliflower with IBA substantially increased plant height, especially with 40mg.l^{-1} rate which showed the highest plant height (60.5 cm). Moreover, this rate strikingly exceeded untreated (55.63 cm), 20mg.l^{-1} (50.93 cm), and 30mg.l^{-1} (49.95 cm). Non-significant differences were detected among untreated, 20mg.l^{-1} and 30mg.l^{-1} (table, 4). Regression results manifested that plant height was declined beyond untreated rates to reach its minimum magnitude at 20mg.l^{-1} then commenced to show step by step increases to attain the highest value at rate of 40mg.l^{-1}. Subsequently, plant height was quadratically responded to IBA rates and it could be estimated by the following equation: (plant height cm = 55.9389 – 0.735193(IBA rate) + 0.020642(IBA rate) ^{**2}). Plant height is influenced by internodes expansion which highly depends on cell enlargements of the intercalary meristem. [9] reported that the analysis of leaf cells in transgenic tobacco lines over-expressing auxin-binding protein (ABP1) indicated the presence of twice as many nuclei in G_2 phase compared to the wild type, suggesting an involvement in cell cycle regulation. Moreover, a tobacco *BY-2* cell line was generated that expressed an antibody to *ABP1*. This antibody binds *ABP1* and blocks its activity *in vivo*. Cells from this line arrested at G_1, further indicating that *ABP1* might function in cell cycle checkpoint regulation.

Effect of IBA on leaves fresh weight per plant

Non-significant differences were observed in the response of plant height to IBA rates. Fresh weight of leaves per plant was decreased to attain its minimum value at 10 mg.l^{-1}rate then revealed gradual increases to get its maximum level at 35mg.l^{-1} rate finally, it declined again (table, 4). Leaves fresh weight responses to IBA rates could be predicted by the following cubic equation: (leaves fresh weight per plant = 568.75 -57.7454(IBA rate) + 3.74131(IBA rate)^{**2} – 0.0575396(IBA rate)^{**3}).

Effect of IBA on leaf number per plant

Significant differences were not observed in the response of leaf number per plant to the sprayed IBA rates (table, 4). Leaf number per plant was increased at rates over 0.0 of untreated check to get its maximum level around 10mg.l^{-1} then declined to minimum level at 35mg.l^{-1} approach 35mg.l^{-1}thereafter it showed increases efficacy (figure, 4).Thus leaves number per plant is governed by the following cubic equation: (leaf number per plant = 13.15 + 0.875(IBA rate) – 0.0598125(IBA rate)^{**2} + 0.0009438(IBA rate)^{**3}).The obtained results suggested that leaf number per plant was generated during very earlier stage before IBA was applied.

Effect of IBA on dry matter accumulation in leaves

Spraying cauliflower plant with 20mg.l^{-1} significantly increased the dry matter percentage of leaves (15.38%), in relation to 40mg.l^{-1} rate (8%), 30mg.l^{-1} (10.08%) and untreated control (10.43%). However, significant differences were not observed among the latter three rates (table, 4). Response of dry matter percentage of leaves to IBA rates (figure, 5) was governed by a quadratic regression type in which dry matter was increased beyond untreated rates to its maximum level around 18mg.l^{-1} rate then values gradually declined. Estimation of dry matter percentage of leaves could be obtained from the following equation: (dry matter percentage of leaves = 10.6543 + 0.418034(IBA rate) – 0.0125398)^{**2}). Dry matter accumulation is facilitated by well established conduit tissues and diverting assimilates to the favour of targeted sink organs. Seedlings germinated on 1-N-aphthaphtalamic acid (NPA) do not form the midvein. Instead, files of veins appear, first along the leaf margins is formed afterward towards the leaf base that are not connected to the hypocotyls vascular system [26].

Effect of IBA on stem fresh weight

Non-significant differences were recorded regarding the response of stem fresh weight to IBA rates (table, 4). Stem fresh weight was linearly responded to IBA rates, and it could be estimated by the following equation: (stem fresh weight g = 92.0607- 0.412143(IBA rate)). Rosette plants possess obligatory stunted stems under cool and short day photoperiod conditions. Therefore stems of such plants show very low participation in growth, so their response to IBA may be ignorable. However, they display very high degree of differentiation which enables them to perform heading. On the other hand, under warm and long day photoperiod most assimilate sink is speared for stem growths.

Effect of IBA on dry matter accumulation in stem

Spraying cauliflower plants by IBA rate of $40mg.l^{-1}$ resulted in significant reduction in dry matter percentage of stem (table, 4). However, significant differences were not detected among other IBA rates. Stem dry matter percentage was linearly correlated to IBA rates and it could be estimated by the following negative equation: (stem dry matter percentage = 25.8393 – 0.110357(IBA rate)).

Effect of IBA on stem length

Significant differences were not found in the response of stem length to IBA rates (table, 4). However, positive linear correlation was found to govern this response, where stem length could be estimated by the following equation: (stem length cm = 27.0464 + 0.06632143(IBA rate)).

Effect of IBA on individual root fresh weight

Apparent differences were not found in the root fresh weight response to IBA rates. In contrast, IBA application on cauliflower plants resulted in root fresh weight reductions in relation to untreated control (table, 4). Regression results revealed that root fresh weight response to IBA rates was governed by the following quadratic equation: (root fresh weight g = 157.509 – 2.75893(IBA rate) + $0.0629205(IBA)^{**2}$).

Effect of IBA on percentage of root dry matter

Non-significant differences were observed in the effects of IBA rates on dry matter percentage of root (table, 4). However, dry matter percentage of root was linearly correlated to IBA rates. It could be forecasted by the following positive linear equation: (dry matter percentage of root = 20.16290 + 0.0644286(IBA rates)).

Effect of IBA on curd total soluble solids

Spraying cauliflower plants by $30mg.l^{-1}$ IBA rate (table, 4) substantially increased the curd TSS percentage (7.05%), as compared to $40mg.l^{-1}$ (5.63%), $30mg.l^{-1}$ (5.79%) and untreated check (5.25%). However, non-significant differences were detected among the latter three rates. Regression analysis revealed that curd TSS was continuously declined at rates beyond zero to reach its minimum level at rate of $7mg.l^{-1}$, then it showed new rising phase to attain maximum level at $35mg.l^{-1}$ rate, finally TSS enter second reduction phase. Therefore TSS was cubically responded to IBA rates, and TSS could be estimated by the following equation: (curd TSS % = 5.25 15 – 0.264375(IBA rate) + $0.0227188(IBA\ rate)^{**2}$ – $0.0003969(IBA\ rate)^{**3}$). These results suggested that the most soft, tender and more juvenile curds were developed at 30mg.l^{-1} IBA-treated cauliflower plants. Since TSS is a measurement of a cell sap that contains 95% sucrose [27].

Effect of IBA on curd circumference
Significant differences were not observed in the response of curd circumference to IBA rates (table, 4). Curd circumference was quadratically responded to IBA rates), as it exhibited reduction phase at rates beyond 0.0 to get minimum magnitude at 20mg.l^{-1} then showed gradual increases at rates beyond 20mg.l^{-1} to achieve the highest value at 40mg.l^{-1}. Curd circumference could be estimated from the following equation: (curd circumference cm =56.0691 – 0.262705(IBA rate) + 0.0084886(IBA) ^{**2}).

Effect of IBA on curd fresh weight
IBA-treated plants (table, 4) with a rate 40mg.l^{-1} gave the highest curd fresh weight (1407 g). Moreover, it significantly exceeded theses of 30mg.l^{-1} rate (890g), 20mg.l^{-1} (1151.4g) and untreated check (1125g). Regression results manifested curd fresh weight increases with the application of IBA rates higher than zero, these increases were ceased at 10mg.l^{-1} rate then followed by reduction stage to attain the lowest magnitude at 30mg.l^{-1} rate , where curd fresh weight showed new increases efficacy, however, these new increases failed to approach the initial highest magnitude. Regression of cubic type appeared to be the most suitable expression for the response of curd fresh weight to IBA rates. Thus the following equation is fitted for the estimation of this parameter: (curd fresh weight g = 1125 + 112.354(IBA rate) – 8.12813(IBA rate)^{**2} + 0.137396(IBA rate)^{**3}) These results suggested that fluctuations in the responses of curd fresh weight might be attributed firstly to the unstable requirement of auxins during different growth and differentiation stages, and secondly to the disintegration of the auxin active from to inactive forms or even to its initial assembling units in the plant tissues. This auxin disassociation is obviously correlated to the ambient environment during any given development stage.This type of hormone degradation is reported by many scientists [28 16].

Effect of IBA on dry matter accumulation in curd
Spraying cauliflower plants with 40 mg.l^{-1} (table, 4) strikingly increased dry matter percentage of curd (11.68%), as compared to IBA rate of 30mg.l^{-1} (8.95%). However, significant differences were not observed among 40mg.l^{-1}, and untreated check. Regression analysis manifested that curd dry matter percentage was declined to minimum level at 10mg.l^{-1} rate then increased step by step to attain maximum level at 33mg.l^{-1} rate, thereafter showed gradual reductions tendency. Thus cubic regression type is governed the response of curd dry matter percentage to IBA rates. These responses could be estimated by the following equation: (curd dry matter percentage = 9.176 – 0.372708(IBA rate) + 0.023125(IBA rate)^{**2} -0.0003479(IBA rate)^{**3}). The obtained results explained the role of IBA in carbohydrate precipitation in cauliflower curd which might be attributed to the influence of IBA on assimilate translocation to their destination in curds. Older primordia leaves accumulate IAA in the leaf tip in the presence and absence of IAA transport inhibition. They propose that the IAA in the shoot apical meristem and the youngest pair of leaf primordia is transported from out sources, perhaps the cotyledons, which accumulate more IAA in the presence than in the absence of transport inhibition [29].

Effect of IBA on individual plant fresh weight

Significant differences were not detected in the response of plant fresh weight to different IBA rates (table, 4). However, plant fresh weight showed quadratic correlation to IBA rates where plant fresh weight commenced to declined at rates beyond zero to reach the lowest magnitude at 20mg.l^{-1} rate then displayed an increasing stage. Subsequently plant fresh weight response to varying IBA rates is governed by quadratic regression type and it could be estimated by the following equation: (individual plant fresh weight kg = 1.81037 – 0.0268453(IBA rate) + 0.0008652(IBA rate) ^{**2}). Auxins facilitate its actions through binding with protein that mediates metabolic processes. The localization of auxin-binding protein (*ABP1*) has caused a great deal of debate, as the majority of *ABP1* has been found with in endoplasmic reticulum (as would be expected to residue on the plasma membrane. Indeed, a number of studies have indicated that a portion of the *ABP1* pool is localized to the plasma membrane, where it is involved in an auxin-mediated membrane hyperpolarization response. *ABP1* is assumed to either bind to plasma membrane docking protein or directly interact with an ion channel (s) [9].

Effect of IBA on marketable curd yield: Spraying snowball plants with 40mg.l^{-1} resulted insignificant marketable curd yield increases, than that obtained from plant treated by IBA rate of 30mg.l^{-1}. However the former rate showed non-significant differences with IBA rates other than 30mg.l^{-1} rate (table, 4). Regression analysis revealed that curd yield was increased at rates over 0.0 to get its maximum level at 9mg.l^{-1} then declined to minimum level at 30mg.l^{-1}, thereafter it showed increases efficacy.Thus curd yield is governed by the following cubic equation: (marketable yield = 5.7375 + 0.599098(IBA rate) – 0.0436278(IBA rate)^{**2} + 0.0007442(IBA rate)^{**3}). Auxins highly influence the differentiation of plant apices. The IAA production and transport could explain the venation pattern and the vascular hypertrophy caused by IAA transport inhibition outside IAA source for the shoot apical meristem supports the notion that IAA transport and procambium differentiation dictate phyllotaxy and organogenesis [29].

Table (4): The effect of IBA on growth and yield of well irrigated snowball cauliflower cv.

Detected Parameters	IBA mg.l^{-1}				Means
	0.0	20	30	40	
Plant height (cm)	55.63ab	50.93b	49.95b	60.50a	54.25
Leaf fresh weights/plant (g)	568.80a	450.10a	650.00a	562.50a	557.85
Leaf numbers / plant	13.15a	14.10a	11.05a	12.85a	12.79
Leaf dry matter (%)	10.43b	15.38a	10.08b	8.00b	10.97
Stem fresh weight/plant (g)	96.95a	95.85a	76.08a	82.28a	87.77
Stem dry matter (%)	24.95a	25.58a	22.20ab	20.70b	23.36
Stem length (cm)	27.38a	28.43a	27.75a	30.50a	28.52
Root fresh weight/ plant (g)	156.98a	130.70a	127.10a	149.43a	141.05
Root dry matter (%)	20.43a	20.50a	22.95a	22.58a	21.62
Curd total soluble solid (%)	5.25b	5.79b	7.05a	5.63b	5.93
Curd circumference (cm)	56.08a	53.77a	55.88a	59.13a	56.22
Curd fresh weight (g)	1125.00ab	1151.40ab	890.00b	1407.00a	1143.35
Curd dry matter (%)	8.43b	9.53ab	8.95b	11.68a	9.65
Plant fresh weight (kg)	1.79a	1.79a	1.62a	2.2a	1.85
Curd yield (kg.m^{-2})	5.74ab	6.22ab	4.54b	7.61a	6.03

Effect of NAA on plant height

Significant differences were observed in the influence of 20, 30 and 40mg.l^{-1} NAA rates, as compared to untreated check (table, 5). However, slight plant height increases were observed among 20, 30 and 40mg.l^{-1} NAA rates. Regression analysis manifested that plant height is linearly responded to the sprayed NAA. This response is positively correlated to different applied rates of NAA, and it could be estimated by the following equation: (plant height cm = 46.0607 + 0.302857(NAA rate).

Effect of NAA on fresh weight of leaves per plant

Spraying snowball plants with NAA highly increased the fresh weight of leaves per plant (table, 5), as compared to untreated check (573.8 g), particularly with 40mg.l^{-1} rate (1450 g). In addition to that non-significant differences were found among the last three NAA rates. Fresh weight of leaves per plant response exhibited positive linear correlation to different NAA rates. The relation of this trait with NAA rates could be forecasted by the next equation: (fresh weight of leaves per plant g = 674.357 + 20.0286(NAA rate)). These results explained the role of auxin on the performance of leaves through its potent actions on leaf generation and venation stature. [29] reported that without midvein, there is no constant basipetal flow of IAA from leaf tips and the IAA produced at the leaf tip, the precursor IAA source of 6 day and older leaves cannot be canalized into specific cell files and cannot experience differentiation of a vascular bundle connected to the plant vascular system. Prior differentiation of the mid vein by flow of auxin into the leaf appears to be required for the latter flow from the leaf tissue to generate the normal venation pattern.

Effect of NAA on leaves number per plant

Application of different NAA rates on snowball plants substantially increased leaves number per plants, as compared to untreated control (23.75). 40mg.l^{-1} was the most effective rate, since it gave the highest number of leaves per plant (29). Moreover, significant differences were not found among varying NAA-treated plants (table, 5). Regression analysis displayed that leaves number per plant was linearly correlated to varying NAA rates, since gradual leaves increases was concomitant with the increasingly NAA rates. This related trait could be estimated by the next positive linear equation: (leaves number per plant = 24.3571 + 0.128571(IBA rate)). Interpretation of these results might be inferred from the role of auxin on cell division which is the base of leaf generation at the apices of plants. The analysis of leaf cells in transgenic tobacco lines over-expressing auxin-binding protein (ABP1) indicated the presence of twice as many nuclei in G_2 phase compared to the wild type, suggesting an involvement in cell cycle regulation. Moreover, a tobacco *BY-2* cell line was generated that expressed an antibody to *ABP1*. This antibody binds *ABP1* and block its activity *in vivo*. Cells from this line arrested at G_1, further indicating that *ABP1* might function in cell cycle checkpoint regulation [9].

Effect of NAA on dry matter accumulation in leaves

The obtained results (table, 5) revealed that snowball–NAA treated plants with 30mg.l^{-1} rate significantly increased dry matter percentage of leaves (15.35%), in relation to 20mg.l^{-1} (10.8%) and untreated check (11.3%). However, the former rate was slightly higher than 40mg.l^{-1} rate (12.23%). Regression results revealed that dry matter percentage of leaves declined at rates beyond zero to get the lowest magnitude at 8mg.l^{-1} then tended to rise to achieve maximum level at 34mg.l^{-1} thereafter it showed new reductions stage. Thus dry matter percentage of leaves is obligated to cubic type of regression, and it could be estimated by the following equation: (dry matter percentage of leaves = 11.3 – 1.16063(NAA rate) + 0.0839688(NAA rat)^{**2} - 0.0013594(NAA rate)^{**3}). These results might be attributed to the influence of NAA on cell differentiation improvement and improving of assimilate source-sink of leaves. Auxins are involved in regulating cellular differentiation. Auxins have a role in the induction of vascular differentiation in shoots. This role is under control of auxins produced in the young, rapidly developing leaves [16].

Effect of NAA on individual stem fresh weight

Spraying cauliflower plants with 40mg.l^{-1} NAA rate profoundly increased stem fresh weight (167.15 g), as compared to untreated check (78.57 g). However, plant treated with the other two NAA rates revealed non-significant differences neither with 40mg.l^{-1} rate nor with untreated control (table, 5). Stem fresh weight was linearly responded to varying NAA rates. The response of this trait to different NAA rates could be estimated by the following positive linear equation: (individual stem fresh weight g = 78.2966 + 2.08699(NAA rate)). Stem experiences the polar transport of auxin and therefore it should be well performed in auxin condition availabilities. Moreover, auxins sustaining lateral bud dormancies for the favour of main stem. IAA is likely transported into the shoot apex, not produced there. However, as leaf primordia grow and mature, IAA is found in the distal end of the leaf regardless of IAA transport inhibition. However, during leaf development, the IAA source changes from extrinsic to intrinsic, which would change IAA flow direction and affect the pattern of vascular differentiation and probably cell and organ differentiation as well [29].

Effect of NAA on dry matter percentage of stem

Spraying snowball plants by 30mg.l^{-1} NAA rates significantly reduced the accumulation of dry matter in stem, as compared to 30mg.l^{-1}NAA. Quadratic regression type was found to fit the effects of varying NAA levels on stem dry matter percentage. Stem dry matter percentage manifested gradual reductions matched with the increasingly NAA rates to 23mg.l^{-1} then continued to rise slightly but it could not restore the untreated record and it could be estimated from the following quadratic equation (stem Dm% = 21.3959 – 0.166784 (NAA rate) + 0.0036648 (NAA rate)^{**2})). These results suggested that most assimilate sink was consumed for the favour of curd and leaves on the account of stunted stem.

Effect of NAA on root fresh weight

NAA-foliar spray of cauliflower plants strikingly improved root fresh weight, as compared to untreated (36.98 g), especially when 40mg.l^{-1} rate (88.11 g) was applied (table,5). Furthermore, non-significant differences were observed among NAA-treated plants. Regression results revealed that root fresh weight was gradually augmented as a result of step by step elevated NAA concentrations. The response of root fresh weight could be estimated by the following positive linear equation: (root fresh weight g = 44.4478 + 1.21529(NAA rate)).These results may be due to the auxin incomes to cauliflower roots. [7] suggested that IBA and IAA enter root cells through the same carrier, as indicated by competition of labeled IBA uptake by excess IAA in *Arabidopsis* seedlings.

Effect of NAA on stem length

Non-significant differences were detected regarding the influence of varying NAA rates application on snowball plants (table, 5). Regression results manifested stem length increases at rates higher than zero and these increases were ceased at 10mg.l^{-1} to start reduction phase which was followed by a new rising phase. Subsequently, stem length response to different NAA rates was trucking a cubic regression curve, and it could be estimated by the following equation: (stem length cm = 12.7 + 0.594687(NAA rate) – 0.0473906(NAA rat)^{**2} + 0.0008328(NAA rate)^{**3}).

Effect of NAA on root dry matter

Spraying snowball by NAA rate of 30mg.l^{-1} significantly reduced the dry matte percentage of root (19.33%), as compared to check (23.43%). However, non-significant differences were noticed among rates other than 30mg.l^{-1} rate (table, 5). Regression results cleared that root dry matter percentage were linearly correlated to the sprayed NAA rates. Increasing the concentrations of the sprayed NAA resulted in corresponding increments in root dry percentage increases. Thus this trait-NAA rates is governed by the next positive linear equation: (root dry matter percentage = 44.4478 + 1.21529(NAA rate)).

Effect of NAA on Curd total soluble solids (TSS)

Non-significant differences were detected in the influence of varying NAA rates on curd TSS (table, 5). However, linear correlation was found between them, which is governed by the following equation: (TSS % = 5.24964 + 0.0168214(NAA rate)).

Effect of NAA on curd circumference

Spraying snowball cauliflower plant by different NAA concentration profoundly increased curd circumference, as compared to untreated. In addition to that, non-significant differences were observed among plants treated with different NAA concentration and all rates substantially exceeded that of untreated (table, 5). Curd circumference was linearly correlated with the influence of different NAA rates. This relation could be predicted by the following equation: (curd circumference cm = 46.0679 + 0.308929(NAA rate)). Curd firmness and compaction are of high significance in relation to the significance of curd circumference since the apices of some lateral buds are protrude out resulting in higher circumference and lower bulk density. Curd circumference is a result of the role of auxins on the developing steps of curd performance. Vascular tissues are conduits for water and nutrients throughout the plant body. They are generated during embryogenesis and organogenesis, expanding along the growth axis of the organ. Vascular development begins with the differentiation of provascular of dicotyledonous embryos such as *Arabidopsis* becomes evident at early heart stage as elongated cells in the center of embryo distinct from the nearly isodiametric surrounding ground tissue cells, as the embryo mature the procambial cells differentiate in to phloem and xylem elements. Vascular tissues connect the leaves and other parts of the shoot with the roots enabling efficient long distance transport between organs [30- 32].

Effect of NAA on individual curd fresh weight

NAA-treated plant gave significantly higher curd fresh weights (table, 5), as compared to untreated control (325 g). Non-significant differences were observed among varying NAA rates; however, the highest curd fresh weight (731.25 g) was accompanied to 30mg.l^{-1} rate. Curd fresh weight was linearly correlated to the different NAA concentration. It could be estimated by the following positive linear equation: (individual curd fresh weight = 362.911 + 7.40536(NAA rate). Curd development is brought about sequence of main and lateral apices divisions and then differentiation which is no doubt promoted by auxin actions on cell division and cell enlargements. Auxin-induced cell enlargement is the basis for the capacity of uxins to initiate and sustain growth of undifferentiated cell when plant are cultured on artificial media. Auxins are involved in regulating cellular differentiation. Auxins have a role in the induction of vascular differentiation in shoots. This role is under control of auxins produced in the young, rapidly developing leaves [16].

Effect of NAA on curd dry matter percentage

Snowball plants treated by 20 and 30mg.l^{-1} highly reduced the dry matter percentage of the curds (9.48 and 9.23%, respectively), as compared to untreated (11.28%) which showed the highest dry matter percentage of curd (table, 5). Curd dry matter percentage was reduced gradually at rates beyond zero till 20mg.l^{-1} then at rates higher than the latter rate, curd dry matter percentage exhibited step by step increases. Therefore quadratic regression is fitted the response of this parameter to varying NAA application. Curd dry matter percentage estimation could be achieved by the next equation: (curd dry matter percentage = 11.3205 – 0.202273(NAA rate) + 0.0048182(NAA rate)^{**2}).

Effect of NAA on fresh weight of individual plant

Spraying snowball plants by varying NAA concentrations profoundly increased individual plant fresh weight, as compared to untreated (0.98 kg) which was the worst treatment (table, 5). Whereas, the most effective treatment was 40mg.l^{-1} as it gave the highest plant fresh weight (2.2 kg). Non- significant differences were detected among the last three NAA rates. Linear correlation was found to govern the influence of different NAA rates on individual plant fresh weigh and this parameter could be predicted by the following equation: (individual plant fresh weight kg = 1115.56 + 29.5209(NAA rate). These results suggested that auxins possesses potent influences on plant development which is in fact an intermingled complex matter, too many processes are implicated, for instance auxin and cellular membrane synergism. [9] reported that no docking protein has yet been identified. Structural studies have indicated that conformational changes in *ABP1* occur upon binding to auxin; such changes might influence the ability of *ABP1* to bind to docking protein or to transmit the signal. With regards to proportion of the *ABP1* pool found at the endoplasmic reticulum (ER) and Golgi, these molecules might interact with a transmembrane protein partner to regulate the secretion of cell wall components necessary for cell expansion.

Effect of NAA on curd yield

NAA-treated plant gave significantly higher yield (table, 5), as compared to untreated control (1.4kg.m^{-2}). Non-significant differences were observed among varying NAA rates, however, the highest yield (3.15kg.m^{-2}) was confined to 30mg.l^{-1} rate. Yield was linearly correlated to the different NAA concentration (figure, 13). It could be estimated by the following positive linear equation: (yield kg.m^{-2} = 1.85084 + 0.0377673(NAA rate)). The molecular mechanism of auxin responses has been shown to involve auxin-binding protein (*ABP1*). This protein mediates cell expansion and possibly also controls the cell cycle [9].

Table (5): The effect of NNA on growth and yield of well irrigated snowball cauliflower cv.

Detected Parameters	NAA mg.l^{-1}				Means
	0.0	20	30	40	
Plant height (cm)	43.81b	55.94a	56.5a	55.25a	52.88
Leaf fresh weights/plant (g)	573.8b	1351.3a	1125.00a	1450.00a	1125.03
Leaf numbers / plant	23.75b	28.30a	28.00a	29.00a	27.26
Leaf dry matter (%)	11.3b	10.8b	15.35a	12.23ab	12.42
Stem fresh weight/plant (g)	78.57b	124.60ab	130.70ab	167.15a	125.26
Stem dry matter (%)	21.33a	19.95ab	19.10b	20.80ab	20.3
Stem length (cm)	12.7a	12.3a	10.38a	13.96a	12.34
Root fresh weight/ plant (g)	36.98b	86.22a	75.86a	88.11a	71.79
Root dry matter (%)	23.43a	22.53ab	19.33b	23.28a	22.14
Curd total soluble solid (%)	5.26a	5.96a	5.50a	6.06a	5.7
Curd circumference (cm)	44.85b	52.95a	58.80a	55.48a	53.02
Curd fresh weight (g)	325.00b	553.13a	731.25a	587.50a	549.22
Curd dry matter (%)	11.28a	9.48b	9.23b	11.08a	10.27
Plant fresh weight (kg)	0.98b	2.03a	1.91a	2.20a	1.78
Curd yield (kg.m^{-2})	1.40b	2.39a	3.15a	2.79a	2.43

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گەشە پێدانی بەرهەمی قرنابیط (***Brassica oleracea var. botrytis cv. Snowball Y IMP***) **بەئاودێری پرژاندن بە هەندێ لە ڕێکخەرانی گەشە کردن .**

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پوختە

تۆڤێ قرنابیتێ ژتوخمێ *Brassica oleracea var. botrysis cv.* Snowball Y IMP **هاتە چاندن دناڤ مالکێن بەرهەمئینانا شتلا دا. ئەڤان شتلا هاتنە چاندن ل سەر مشارا دناڤ زەڤیێ بەردەوام دا وهاتنە ڕەشاندن ب ترشێ جبرلیك** (GA_3) **دوو جاران وبرێژێن ژێك جودا** (0، 21، 30، 40 **ملغم/ لتر**). **ڕەشاندنا ئێکێ هاتە بجهئینان پشتی دوو حەفتیا ژڤەگوهاستنا شتلا بو زەڤیێ ورەشاندنا دووێ هاتە بجهئینان پشتی جوار هەیڤا ژبۆ چاککرنا بەرهەمێ قرنابیتێ ژتوخمێ** Snowball Y IMP **ئەوێ هاتیە ئاڤدان پشتی مەزاختنا** 25٪ **ژئاڤا بەردەست دناڤ ئاخێ دا ول سەر کویراتیا** 30 **سم. ئەنجامێ ڤەکولینێ دیارکر کو توخمێ قرنابیتێ** Snowball Y IMP **بێتڤیێ ئاڤدانەکا تەکمیلی بوو ب رێژا** 327.6 **ملم ژبلی** 254،3 **ملم ژبارانێن هاتینە بارین دماوێ وەرزێ چاندنێ دا. ڕەشاندنا ترشێ جبرلیك بوویە ئەگەرێ زێدەبوونەکا بەر چاڤ دبەرهەمێ قرنابیتێ نە خاسمە درێژەیا** 40 **ملغم/ لتر ئەوێ بلندترین بەرهەم دای** (3.6 **کغم/ م**^{2}) **ددەمێ بەراوەردکرنێ دگەل قرنابیتێن نە هاتینە ڕەشاندن** (2.44 **کغم/ م**^{2}). **هاتنا بەرهەمی دبیت بهێتە حسابکرن ل دویف معادلا ل خوارێ: بەرهەم کغم/ م**^{2} = 2.35836 + 0.0313786 (**رێژا** GA_3). . **ڕەشاندنا ترشێ بیوتیریك ل سەر بەلگان بوویە ئەگەرێ چاککرنا بەرهەمی ب شیوەکێ بەرچاڤ نە خاسمە ددەمێ بکارئینانا ریژا** 40 **ملغم/ لتر ئەوێ بلندترین بەرهەم دای وگەهشتیە** 7.6 **کغم/ م**^{2} **ددەمێ بەراوەردکرنێ دگەل بەرهەمێ قرنابیتێ ئەوێ نە هاتیە ڕەشاندن** (5.74 **کغم/ م**^{2}). **ئەنجامێن ئینحیدارێ دیاردکەن کو هاتنا بەرهەمێ قرنابیتێ ل دویف ڕەشاندنا ترشێ بیوتیریك دبیت بهێتە حسابکرن ب رێکا خوارێ : بەرهەم کغم/ م**^{2} = 5.7375 + 0.0599.98 (**رێژە**) – 0.0436278 (**رێژە**)^{2**} + 0.0007442 (**رێژە**)^{3**} . **ڕەشاندنا رووەکێن قرنابیتێ ب** (NAA) **بوویە ئەگەرێ زێدەبوونەکا بەرچاڤ دبەرهەمیدا نە خاسمە ددەمێ ڕەشاندنێ ب رێژا** 30 **ملغم/ لتر ئەوێ بلندترین بەرهەم دای وگەهشتیە** 3.15 **کغم/ م**^{2} **ددەمێ بەراوەردکرنێ دگەل قرنابیتێن نە هاتینە ڕەشاندن** (1.4 **کغم/ م**^{2}). **هاتنا بەرهەمێ قرنابیتێ ل دویف رێژێن** NAA **هاتیە ل دویف معادلا ل خوارێ: بەرهەم کغم/ م**^{2}= 1.85042 + 0.0377673 (**رێژا** NAA).

تحسين انتاج القرنابيط (*Brassica oleracea var. botrytis cv. Snowball Y IMP*) المروي جيدا بواسطة الرش ببعض منضمات النمو

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الخلاصة

زرعت بذور القرنابيط صنف (*Brassica oleracea var. botrytis cv. Snowball Y IMP*) في الالواح لانتاج الشتلات وتم زراعة هذه الشتلات على المروز في الحقل المستديم ثم رشت مرتين بحامض الجبرليك وباندول حامض البيوتارك ونفثال حامض الخليكNAA) وبمعدلات صفر ،20 , 30 ، 40 ملغم / لتر, الرشة الاولى كانت بعد اسبوعين من النقل للحقل المستديم والرشة الثانية اجريت بعد أربعة أشهر بهدف تحسين الانتاج في صنف القرنابيط Snow*ball Y IMP* المروي عند استنزاف 25% من الماء الجاهز في التربة ولعمق 30سم. أظهرت النتائج بأن صنف القرنابيط *Snowball Y IMP* احتاج ريا تكميليا يعادل 327.6 ملم بالاضافة الى 254.3 مل من الامطار الساقطة خلال موسم النمو . أدى الزش بحامض الجبرليك الى زيادة حاصل القرنابيط معنويا خاصة عند معدل 40 ملغم /لتر حيث اعطى اعلى حاصل(3.6 كغم/م ^{2}) مقارنة مع النباتات غير المعاملة (2.44 كغم/م ^{2}) وان استجابة الحاصل يمكن حسابها من معادلة الانحدار التالية (الحاصل كغم / م ^{2} = 2.35836 + 0.0313786 (معدلGA3). . ان الرش الخضري لاندول حامض البيوتاريك ادى الى تحسين الانتاج معنويا خاصة عند المعدل 40 ملغم / لتر حيث اعطى اعلى انتاج (7.6 كغم / م ^{2}) مقارنة مع حاصل النباتات غير المرشوشة (5.74 كغم/ م ^{2}). تؤكد نتائج الانحدار بأن استجابة حاصل القرنابيط الى الرش بأندول حامض اليبوتاريك ممكن ان تحسب بواسطة المعادلة التالية (الحاصل كغم/ م ^{2} =5.7375 +0.0599.98 (معدل)- 0.0436278 (معدل)** ^{2} +0.0007442 (معدل)^{3**} . . ان رش النباتات بنفثال حامض الخليك ادى الى زيادة الحاصل معنويا خاصة عند الرش بمعدل 30 ملغم/لتر حيث اعطى اعلى حاصل 3.15 كغم/م^2 مقارنة مع حاصل النباتات غير المعاملة (1.4 كغم/م^2) .كانت استجابة الحاصل لمعدلات NAA تحكم بالمعادلةالخطية التالية (الحاصل كغم/م ^{2} = 1.85042 +0.0377673 (معدل NAA

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