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The possibility of Green Bean Production in the Off-Season Open Field Despite Low Temperature under Egyptian conditions

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ABSTRACT

This study was performed at Barrage Horticulture Research Station, Qalubia governorate, Egypt to investigate the impact of snap bean (*Phaseolus vulgaris* L.) production under open field conditions and inappropriate low temperatures during off-season on plant growth and green pods yield and quality features e.g. plant length, plant fresh and dry weight and plant content of nitrogen, phosphorus and potassium as well as total and marketable pods yield (ton/ fed), average pod weight and pods pigments content e.g. chlorophyll a and b and charotinoides. Snap bean seeds were sown at three dates of December 1st, January 1st and February 1st within successive growing seasons of 2011/2012 and 2012/2013. During vegetative growth, plants were sprayed with three plant stimulant substances of Glycine Betaine at rate 5 mM/L, Naphthalene acetic acid at rate 20 ppm and Salicylic acid at rate 1 mM/L in addition to control treatment which sprayed with distilled water. In both experimental seasons, the data clearly indicate that plant vegetative growth parameters expressed as plant length and plant fresh and dry weight in addition to plant content of nitrogen, phosphorus and potassium as well as total and marketable green pods yield, average pod weight and pods pigments content have been affected significantly by seed sowing dates and foliar spray with such plant stimulant substances. Therefore the highest values of all of these parameters were obtained when seeds were sown on February 1st compared to sowing on January 1st or December 1st. Furthermore the foliar spray substances recorded better plant growth and nutrients content and pods yield and quality than control treatment. The highest values of these parameters were recorded with spraying plants with salicylic acid followed by Glycine betaine and then naphthalene acetic acid compared to control treatment.As for the interaction between seed sowing dates and foliar spraying substances, the highest values of the growth and yield were achieved by sowing seeds on February1st and then spraying plants with salicylic acid compared to other combinations between seed sowing dates and spray substances or control. Otherwise, the least plant performance was recorded when sowing seeds on December 1st accompanied by spraying plants with distilled water. Although the correlation of best growth and marketable yield of pods with sowing seeds on February comparing to that of December and January, but it is worth mentioning that succeeding snap bean cultivation and production during this period, even with low marketable pods yield, achieved a higher profit because of low production cost compared to protected cultivation and high yield price. The worst temperature prevalent during this period, which limits the plant growth and subsequently pods yield and quality, can be alleviated through spraying plants with the above mentioned stimulants especially salicylic acid.

Key words: Green bean, sowing date, plant growth, yield, Glycine betaine, Naphthalene acetic acid, Salicylic acid.

Introduction

Snap bean (*Phaseolus vulgaris,* L.) is one of the most important members of fabaceous family in Egypt either for local consumption or for exportation. Cultivation of snap bean is dominated by produce green pods comparing to produce seeds. Green bean is cultivated and consumed throughout the year because it remunerative to the farmer as they fetch higher price in the market. Green bean is annual summer crop grown in open field along the year except cold times in winter conditions wherever it could be produced protected under either low tunnels or green houses. According to statistic of Egyptian agricultural ministry 2012, green bean production under protected cultivation constitutes less than 20% of

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snap bean cultivation area and achieves high returns because of less production and less crop supply for local consumption moreover more demand for exportation. Climate changing led to changes in seasonal and monsoon pattern and biotic and abiotic factors as crop situation, status of yields and quality and pest and disease problems (Ayyogari *et al.,* 2014 Thus the experiment involved three sowing dates away of custom dates of green bean cultivation during late fall and early winter season so low temperature is dominated. The low temperature in which dates constitutes a low heat stress on cultivated green bean plants, Sowing date clearly affect plant growth and productivity through the timing and duration of the vegetative and reproductive stages because of the environmental factors such as temperature and light duration are differ with varying sowing date and have direct effects on physiological processes such as photosynthesis and respiration. (Mahmoud, 2008). Govindan *et al*. (2000) indicated that spraying soybean plants with NAA at 40 ppm after 35 days of sowing had significant increases in growth characters, yield and its attributes including number of pods and seeds, plant, seeds/pod and 100 seed weight.Salicylic acid is a bio-regulator use as an emerging plant biotechnology approach which can modify plant gene expression, can affect levels of DNA, RNA, enzymes and finally their products such as protein, carbohydrates, lipids, allele chemicals for enhancing yield and phytonutrients in food crops (Olaiya *et al.,* 2013). Senthil *et al*., (2003) indicated that soybean plants sprayed with NAA had significant increases in growth characters. Khanzada *et al.,* (2002) obtained highest values for plant height, number of leaves per plant, number of branches per plant, leaf area, dry matter and days to maturity when NAA was applied at 15 days after emergence stage the experimental substances. Karim *et al.,* (2006) also sprayed with application NAA of bio-regulators encourages the uptake of nitrogen from the soil and may activate transaminase enzyme which in turn increases the quality of grain on chickpea, Agboma *et al*., (1997) foliar application of GB increase photosynthesis activity, nitrogen fixation and leaf area development in well-irrigated and drought-stressed soybean plants. Ashraf and Follad, (2007) stated that foliar application of exo-GB had positive effects on plant growth under drought stress of common bean. Mäkelä *et al*., (2000) stated that application of glycine betaine (50-100 mM) significantly improves chlorophyll concentration of tomato grown under drought and salinity conditions. Basu *et al*., (2010) Glycine betaine (GlyBet) amino acid has been found to act as improve the growth and development of plants exposed to a variety of abiotic stresses including drought, temperature and salinity. Previous studies have demonstrated that biochemical, physiological and morphological changes occur in plants in response to water deficit on rice plants. (Kazemi, 2014) SA-sup has been reported to differentially benefit several plant species exposed to low/chilling temperatures and subsequently more fruit setting and productivity on *Brassica napus* L. Hussain *et al*., (2010) Salicylic acid also retards ethylene synthesis, stimulate photosynthetic machinery, increases the chlorophyll content and is reported to increase grain yield in cereals and legumes under temperature stress condition (Hayat *et al,*. 2010, Kumar *et al,*. 2013). Maghsoudia and Arvinb, (2010)and Zahra *et al.,* (2010), indicated that spraying to induce a protective mechanism for enhancing plant resistance to biotic and abiotic stresses on the tomato. Szepesi *et al*., (2011). El-Shraiy and Hegazi (2009) found that application of acetyl salicylic acid (ASA) at 20 ppm on pea plants enhanced plant growth as indicated by plant height , fresh and dry weights in both seasons. Abou El-Yazied (2011) foliar application of glycine betaine is an amphoteric amine and produced by plants in varied quantity therefore allows the crop to sustain growth despite stressful conditions improves seed production and quality of common Bean Balwinder *et al.,* (2014) proved that application of salicylic acid improves grain yield and its nutritional quality on cowpea. Abdel-Ati *et al*., (2000) which revealed that salicylic acid has a direct role in tomato plant growth, flower induction and uptake of ions. Kamal and Abd Al Gaid (2008) showed that spray pea plants with ascorbic acid combined with salicylic acid increased pod setting percentage, average weight of pod, number of seeds/pod, 100 green seeds weight and total pod yield of pea . Ali *et al.* (2009) stated that 1.5 mM of salicylic acid had a stimulating effect on the amino acid content mg/100g compared with other concentrations 5 and 10 mM. Khan, (2010) reported that salicylic acid foliar spray on soybean plants at lower concentration increased plant height, chlorophyll content, number of branches, leaves per plant and dry weight. Ananthi and Mallika (2013) found that spraying salicylic acid improved the total chlorophyll content of green gram pods. Sakamoto and Murata, (2002). Abdel-Hakim (2012) found that sowing snap bean seeds at October 25th and November 15th under open field cool conditions and spraying plants with salicylic acid, the low concentrations of salicylic acid (0.5 - 1.0 mM) improved plant growth. Ashraf and Follad,(2007) many articles demonstrated the positive effects of spraying glycine betaine on plant growth and final crop yield under stress. Heshmat *et al.,* (2012) found that foliar spray glycine betaine and salicylic acid of wheat cultivars grown under water deficit condition and increased grain quality indices. Shokr (2014) stated that foliar application of salicylic acid on snap bean greatly enhanced the tolerance of adverse conditions, which were manifested by improving vegetative growth. Singer *et al*., (1996) which

prove that sowing snap bean at 29th of February showed the highest plant height, number of leaves and plant fresh and dry weight compared with other sowing dates of 9th, 19th of February. Ramirez *et al.* (2008) Found that the vegetative growth of snap bean plants was positively affected by sowing dates on 10th of October and 7th of February compared to those of November, December and January. Abou El-Yazied, (2011) conditions found that snap bean vegetative growth parameters i.e., plant height, leaves number, leaf area and plant dry weight at 50 days after sowing significantly recorded the highest values at the early sowing date on 1st of October compared to sowing dates of 15th and 30th of October. This means that the best sowing dates are in which higher temperatures degrees available. Abd El-Latif *et al.* (2009) found that planting on 15th of March gave the highest significant values in plant height, number of branches / plant, fresh and dry weight / plant of cowpea plants as compared to planting on 15th of February and 1st of March. Ewas (2010) on snap bean found that the third date on 15th of February gave the highest plant height, fresh weight per plant and leaf area compared with the 15 and 30th of January but the 15th of January was the best in number of leaves per plant. Amer (2004), in Egypt, noted that the vegetative growth of snap bean plants was clearly affected by sowing dates and the highest values of dry weight per plant were recorded by sowing on 10th of October and 7th of February compared to those of 1st November, 10th December and 10th.

Therefore the aim of this study is to operationalize adaptation of green bean production to climate changes within try to delay cultivation date in fall or early in winter in open field to without protection take advantage of a higher return of green bean production at off-season. Also the present work involved spraying plant stimulant substances as Glycine Betaine, Naphthalene acetic acid and Salicylic acid on plant aerial parts to mitigate the heat stress.

Materials and Methods

Two field experiments were conducted during late fall to early summer seasons of 2011/2012 and 2012/2013 at Barrage Horticulture Research Station, Qalubia governorate, Egypt. The soil was clay loam with pH of 8.28 to investigate the impact of seed sowing dates during off-season and foliar spraying with Glycine Betaine at rate 5 mM/L, Naphthalene acetic acid and at rate 20 ppm and Salicylic acid at rate 1 mM/L on snap bean growth, productivity and pods quality. The Mechanical & chemical analyses and meteorological data of the experimental area illustrated in Table, (1 and 2).

Table 1: Mechanical and chemical analyses of the soil during 2011/ 2012 and 2012/2013 seasons

	2011/ 2012	2012/ 2013
PH (in 1-25 suspension)	8.31	8.50
EC mmhos	2.70	2.76
Texture class	Clay	Clay
Organic matter %	1.06	1.03
Total N (ppm)	112.95	120.12
Total P (ppm)	12.45	11.34
Total K (ppm)	561.71	572.43

Table 2: Local meteorological data at Qalubia governorate region during 2011/ 2012 and 2012 / 2013 seasons

Month	2011/2012			2012/2013		
	Temperature (º C)		Relative humidity (%)	Temperature (º C)		Relative humidity (%)
	Max.	Min.	Aver.	Max.	Min.	Aver.
Dec.	18.3	7.5	82	19.5	7.1	85
Jan.	22.9	9.4	85	23.2	9.8	83
Feb.	24.6	10.8	78	25.8	10.8	80
Mar.	27.1	11.2	80	28.6	11.5	85
April	32.6	12.9	86	34.3	12.3	86
May	37.9	19.2	75	38.7	20.5	77
June	41.4	20.8	85	40.4	19.2	85

Plant materials and experimental design:

Snap bean seeds of Paulista cultivar from Suez Canal seed company were sown at one side of the row and the plant distance 10 cm at three dates of December 1st, January 1stand February1st. The plants were

foliar sprayed during plant growth period with Glycine betaine at 5 mM/L, Naphthalen acetic acid at 20 ppm, Salicylic acid at1 mM/L and distilled water as control treatment.The plants were sprayed three times begin after appearance of fourth true leaf and then each two weeks intervals.Treatments were arranged in split-split-plot design and replicated three times. The main plots contained sowing dates treatments meanwhile, foliar spray treatments were randomly distributed in the sub plots. Each experimental plot contained 3 rows, each row was 4 m linear and 0.6 m width. So the area of each plot was 7.2 m^2. All agricultural practices were carried out as recommended for the conventional snap bean production published via agricultural ministry in the experimental location.

Recorded data:

All vegetative growth attributes were measured at the onset of flowering stage after 50 days from sowing date. Ten random plants from each treatment were randomly chosen, uprooted and subjected for data collection. After sampling in the field, samples were immediately transferred to the lab (Self-pollinated Vegetable Research Department) where data collection was carried out as follows.

- *Plant growth:*

Plant length (cm), plant fresh weight (g) and plant dry weight (g).

- *Pods yield and its components:*

Average pod weight (g), estimated pods yield (ton/ fed.) and marketable yield (ton/fed).

- *Chemical analysis of plants and pods:*

From each plot, sample of five plants from the above mentioned ten plants were randomly chosen and were dried at 70C^o to fixed weight. Dried samples were grinded and digested using a mixture of sulphuric acid (H_2SO_4 98 %) and hydrogen peroxide (H_2O_2 30 %) as described by Thomas *et al*. (1967). The studied elements were assayed in the digest extract of the concerned plant samples. Total nitrogen was determined using micro-Kjeldahl apparatus as described by Pregl (1945). Phosphorus content was measured calorimetrically according to the method described by Murphy and Riley (1962) as modified by John (1970). Potassium was measured by flame photometer as described by Brown and Lilleland (1946). Total free amino acids (mg/100g of snap bean pods were measured according to the method described by Rosen (1957). Photosynthetic pigments content of fresh pods as chlorophyll a and b and carotenoids (mg/100 g FW) according to the method described by Wettestein (1957).

Statistical Analysis, All the collected data were tabulated and statistically analyzed using the analyses of variance method as reported by Snedecor and Cochran, (1980) and the treatments means were compared using the Duncan Multiple Range test (Duncan, 1955).

Results and Discussion

Effect of seed sowing date and foliar application of some plant stimulants on vegetative growth of snap bean plants:

Data in Table (3) show that the plants attitude attains significant responses to seed sowing dates and foliar spray with plant stimulants of Glycine betaine, naphthalene acetic acid and salicylic acid. Thence, plants sown on February 1st date and received salicylic acid spray were more superior in the measured parameters e.g. plant length and plant fresh and dry weight followed by sowing seed on February 1st and spraying with Glycine betaine. Otherwise, spraying the plants on December 1st with distilled water recorded the lowest values of plant length and plant fresh and dry weight. The best plant attitude was gained when sowing seeds on February 1st but the lowest attitude was found when seeds were sown on December while sowing plants on January 1st showed moderate effect. The data demonstrates an obvious descending impact of snap bean plants vegetative growth attributes through spraying the plants with salicylic acid, Glycine betaine, and naphthalene acetic acid respectively, compared to spraying distilled water as control. Finally, spraying plant stimulant substances of salicylic acid, Glycine betaine and naphthalene acetic acid as well as distilled water on sown plants on February 1st recorded the highest

values of plant vegetative growth parameters than those sown on December 1st or January 1st. Otherwise spraying salicylic acid on plants were sown on January forever and sometimes on December recorded the highest growth features values than spraying distilled water in all three sowing dates under the experiment conditions. So that it could be emphasized that spraying the above mentioned plant stimulant substances especially salicylic acid as stress alleviators on snap bean plants led to enhancing the growth of snap bean plants which grown in open field during off-season at the first of December to the first of February.

According to the meteorological data shown in table 2, the measured temperature expressed as minimum and maximum record, the degrees recorded the lowest values on December (7.5, 18.3˚C) but the highest degrees were recorded on February (10.8, 24.6˚C) while on January the minimum and maximum temperature recorded 9.4, 22.9˚C which laid between those recorded on December and February. Regarding to snap bean plants behavior, it has been well known that snap bean as a summer crop does not tolerate low temperature so that sowing snap bean seeds at the experimental dates without protection will exposing the plants to low temperature stress. Therefore the temperature degrees variation between the dates from December to February confirms that the plants grown during February proved the best performance followed by those grown on January but the lowest plant attitude was conferred by plants grown on December. Otherwise, data shown in table 5 reflected the consistency of the impact of combined seed sowing dates and foliar spray with salicylic acid, Glycine betaine and naphthalene acetic acid on both snap bean plants growth and its nutrients, thus plant growth features have been enhanced as plant nutrients content increased. Our findings are in accordance with those of Singer *et al*., (1996), Ramirez *et al.* (2008) and Abou El-Yazied, (2011) on snap bean.

Table 3: Effect of sowing date and foliar application of some plant stimulants on plant length and plant fresh and dry weight of snap bean plants grown during 2011-2012 and 2012- 2013 seasons.

2011-2012							2012-2013				
Plant length (cm)											
Sowing date	Foliar applications					Sowing date	Foliar applications				
	Cont.	GB	NAA	SA	Mean		Cont.	GB	NAA	SA	Mean
Dec.	32.20 h	44.70 f	39.17 g	49.30 e	41.34 C	Dec.	36.60 h	45.97 f	41.31 g	48.72de	43.42 C
Jan.	37.95 g	54.20 d	44.73 ef	59.22 bc	49.02 B	Jan.	39.09 gh	50.94 cd	48.53 ef	53.06 c	47 .34 B
Feb.	46.83 ef	60.65 b	55.73 cd	67.12 a	57.58 A	Feb.	46.62 ef	56.82 b	52.71 c	62.05 a	54.22 A
Mean	38.99 D	53.18 B	46.54 C	58.54 A		Mean	40.77 D	51.24 B	47.52 C	54.61 A	
Plant fresh weight (g/ plant)											
Dec.	18.27 i	24.67 f	22.54 gh	24.67 f	23.01 C	Dec.	16.97 h	24.00 f	21.82 g	27.03 e	24.46 C
Jan.	20.76 h	27.51 e	24.52 fg	31.13 d	25.98 B	Jan.	19.36 gh	27.37 e	24.52 f	30.23 d	28.33 B
Feb.	30.93 d	38.01 b	35.37 c	41.36 a	36.41A	Feb.	30.28 d	39.23 b	35.77 c	42.41 a	38.92 A
Mean	23.32 D	30.07 B	27.47 C	33.02 A		Mean	22.22 D	30.20 B	27.37 C	33.17 A	
Plant dry weight g/ plant											
Sowing date	2011-2012				Mean	Sowing date	2012-2013				Mean
	Foliar applications						Foliar applications				
	Cont.	GB	NAA	SA			Cont.	GB	NAA	SA	
Dec.	9.52 g	14.36 ef	12.91 f	16.45 d	13.31C	Dec.	9.76 f	14.55 e	13.07 e	17.17 cd	13.04 C
Jan.	10.75g	17.44 cd	15.73de	19.91 b	15.96B	Jan.	11.13 f	16.85cd	14.72 e	18.47bc	15.29 B
Feb.	13.63f	20.10 b	18.60 bc	22.28 a	18.65A	Feb.	13.31 e	18.99 b	16.43 d	20.96 a	17.42 A
Mean	11.30D	17.30B	15.75C	19.55A		Mean	11.40 D	16.80 B	14.74 C	18.87A	

Means followed by the same letter are statistically not significant according Duncan's multiple range test (P=0.05).
Cont = Control GB = Glycine betaine NAA=Naphthalena acetic acid SA = Salicylic acid
Dec. = December Jan. = January Feb. = February

As reported by some researchers, the experimental substances e.g. Glycine betaine, naphthalene acetic acid and salicylic acid play important role of stress alleviation on different plants. (Hussain *et al*., 2010) on snap bean, (Maghsoudia and Arvinb, 2010) on wheat (Zahra *et al*., 2010, Szepesi *et al*., 2011) on the tomato, El-Shraiy and Hegazi (2009 on pea plants, Khan, (2010) on mung bean plants, Ashraf and Follad, (2007) on common bean. Makela *et al.*, (1996) and Agboma *et al*., (1997) on soybean plants. Mäkelä *et al*., (2000) on tomato, Khanzada *et al.*, (2002), Govindan *et al*. (2000) and Senthil *et al*., (2003) on soybean plants Abou El-Yazied, (2011) , Shokr (2014) on snap bean.

Effect of seed sowing date and foliar application of some plant stimulants on total and marketable pods yield and average pod weight of snap bean plants:

Data in Table (4) illustrate significant increment of pods yield component and average pod weight for the plants sown at the tested sowing dates compared to spraying Glycine betaine and naphthalene acetic on

plants grown in the same dates. On the other hand spraying the plants with distilled for the three sowing dates recorded the lowest values of yield components and pod weight. Therefore we can say that in terms of planting dates, snap bean seed sowing on February1st gained the highest pods yield components and pod weight while, spraying salicylic acid attain the superior effect among the plant stimulants, in the two seasons. Referring to the meteorological data in table 2 and snap bean plant growth (Table, 3) and yield (Table, 4) the temperature prevailing during February was almost appropriate for plant growth as well as nutrient absorption (Table, 5) and subsequently increment of pods yield and its quality more than that of December or January.

Table 4: Effect of seed sowing date and foliar application of some plant stimulants on total and marketable pods yield (ton/fed) and average pod weight of snap bean plants grown during 2011-2012 and 2012-2013 seasons.

2011-2012						2012-2013					
Total yield (ton/fed)											
Sowing date	Foliar applications					Sowing date	Foliar applications				
	Cont	GB	NAA	SA	Mean		Cont.	GB	NAA	SA	Mean
Dec.	2.957 h	3.469 f	3.298 g	3.711 e	3.354 C	Dec.	2.94 h	3.35 e	3.23 fg	3.52 d	3.26 C
Jan.	3.239 g	3.624 e	3.476 f	3.909 d	3.56 3 B	Jan.	3.12 g	3.549 d	3.34 ef	3.71 c	3.43 B
Feb.	4.059 c	4.343 b	4.277 b	4.583 a	4.31 2 A	Feb.	3.50 d	3.991 b	3.75 c	4.13 a	3.84 A
Mean	3.412 D	3.8124 B	3.684 C	4.068 A		Mean	3.193 D	3.630 B	3.442 C	3.790 A	
Marketable yield (ton/fed.)											
Sowing date	2011-2012				Mean	Sowing date	2012-2013				Mean
	Foliar applications						Foliar applications				
	Cont.	GB	NAA	SA			Cont.	GB	NAA	SA	
Dec.	1.34 i	1.74 g	1.60 h	1.98 f	1.69 C	Dec.	1.31 j	1.79 h	1.63 i	2.04fg	1.67 C
Jan.	1.71 g	2.22 e	1.94 f	2.37 d	2.02 B	Jan.	1.68 hi	2.12 f	1.95 g	2.33 e	2.06 B
Feb.	2.34 d	2.96 b	2.69 c	3.17 a	2.90 A	Feb.	2.57 d	2.97 b	2.81 c	3.23 a	2.79 A
Mean	1.85 D	2.29 B	2.13 C	2.53 A		Mean	1.80 D	2.31 B	2.08 C	2.51 A	
Pod weight (g)											
Sowing date	2011-2012				Mean	Sowing date	2012-2013				Mean
	Foliar applications						Foliar applications				
	Cont.	GB	NAA	SA			Cont.	GB	NAA	SA	
Dec.	3.10 e	3.48 b-d	3.42 de	3.54 b-d	3.45 C	Dec.	3.24 f	3.57 de	3.50 de	3.76 cd	3.50 B
Jan.	3.44 c-e	3.68 a-d	3.58 b-d	3.88 ab	3.67 B	Jan.	3.54c-e	4.02 b	3.77 c	4.12 b	3.84 A
Feb	3.60 a-d	3.84a-c	3.78 a-c	4.04 a	3.85 A	Feb.	3.72 c	4.00 b	3.82 c	4.51 a	3.97 A
Mean	3.47 C	3.69 B	3.60 BC	3.85 A		Mean	3.38 D	3.86 B	3.70 C	4.13 A	

Means followed by the same letter are statistically not significant according Duncan's multiple range test (P=0.05).
Cont. = Control GB = Glycine betaine NAA= Naphthalena acetic acid = SA = Salicylic acid
Dec. = December Jan. = January Feb. = February

Effect of seed sowing date and foliar application of some plant stimulants on nitrogen, phosphorus and potassium percentage of snap bean plants:

Nitrogen, phosphorus and potassium nutrients content of snap bean plants content of were analyzed and tabulated in Table (5).

In general, the highest values of the three nutrients were recorded in sown plants on February1st and then were sprayed with salicylic acid through the two seasons while the least nutrients content values were obtained when sowing plants on December 1st and were sprayed with distilled water. For all sowing dates, spraying snap bean plants with Glycine betaine looked ahead to NAA in plant nutrients content values while remaining the two treatments are better than control but less than salicylic acid spraying treatments. Otherwise, spraying plant stimulant substances of salicylic acid, Glycine betaine and naphthalene acetic acid as well as distilled water on sown plants on February 1st recorded higher values of plant nutrients content than the counterparts sown on December 1st or January 1st. Spraying salicylic acid on January and sometimes on December recorded higher nutrients content values in plants than spraying distilled water in all tested sowing dates. So that it is possible for prolongation of open field green bean production in off-season, sowing seeds during the first of December to the first of February, and spraying the above mentioned plant stimulant substances, especially salicylic acid, as stress alleviators on snap bean plants. As shown in Table (3), the meteorological data proved that sowing seeds on February1st where the available temperature was more appropriate for plant growth and physiological activities than that on December and January. Nutrients uptake is an important one of the plant physiological activities that its efficiency depends on root surface area and net assimilates as energy source for nutrients uptake (Ostonen *et al*., 2007).

Table 5: Effect of sowing date and foliar application with salicylic acid, Glycine betaine and naphthalene acetic acid on nitrogen, phosphorus and potassium percentage of snap bean plants grown during 2011-201 and 2012-2013 seasons.

Sowing date	2011-2012				Mean	Sowing date	2011-2012				Mean
	Foliar applications						Foliar applications				
	Cont.	GB	NAA	SA			Cont.	GB	NAA	SA	
Dec.	1.82 f	2.38 de	1.95 f	2.61 cd	1.43 C	Dec.	2.39 e	2.85 d	2.56 e	2.88 d	1.76 C
Jan.	2.20 ef	2.72 b-d	2.43 de	2.93 bc	1.85 B	Jan.	2.90 d	3.32 c	3.01 d	3.39 bc	1.97 B
Feb.	2.50 de	3.08 ab	2.99 a-c	3.35 a	1.99 A	Feb.	3.33 c	3.53 ab	3.44 bc	3.69 a	2.30 A
Mean	1.50 D	1.87 B	1.67 C	2.00 A		Mean	1.74 C	2.17 A	1.93 B	2.21 A	
potassium percentage											
Sowing date	2011-2012				Mean	Sowing date	2011-2012				Mean
	Foliar applications						Foliar applications				
	Cont.	GB	NAA	SA			Cont.	GB	NAA	SA	
Dec.	1.82 f	2.38 de	1.95 f	2.61 cd	2.67C	Dec.	2.39 e	2.85 d	2.56 e	2.88 d	2.19 C
Jan.	2.20 ef	2.72 b-d	2.43 de	2.93 bc	3.16 B	Jan.	2.90 d	3.32 c	3.01 d	3.39 bc	2.57 B
Feb.	2.50 de	3.08 ab	2.99 a-c	3.35 a	3.50 A	Feb.	3.33 c	3.53 ab	3.44 bc	3.69 a	2.98 A
Mean	2.87 D	3.23 B	3.01 C	3.32A		Mean	2.17 D	2.73 B	2.46 C	2.96 A	
Phosphorus percentage											
Sowing date	2011-2012				Mean	Sowing date	2011-2012				Mean
	Foliar applications						Foliar applications				
	Cont.	GB	NAA	SA			Cont.	GB	NAA	SA	
Dec.	0.37 g	0.44 d	0.40 ef	0.49 c	0.42 C	Dec.	0.43 h	0.48 f	0.46 g	0.49 ef	0.47 C
Jan.	0.39 f	0.49 c	0.43 d	0.52 b	0.46 B	Jan.	0.45 gh	0.52 cd	0.48 f	0.54 bc	0.50 B
Feb.	0.41 e	0.54 b	0.49 c	0.57 a	0.50 A	Feb.	0.48 g	0.55 ab	0.51 de	0.57 a	0.55 A
Mean	0.39 D	0.49 B	0.44 C	0.53 A		Mean	0.45 D	0.52 B	0.48 C	0.57 A	

Means followed by the same letter are statistically not significant according Duncan's multiple range test (P=0.05).
Cont. = Control GB = Glycine betaine NAA =Naphthalena acetic acid SA = Salicylic acid
Dec. = December Jan. = January Feb. = February

Effect of seed sowing date and foliar application of some plant stimulants on total free amino acids content of snap bean plants:

Data shown in Table (6) confirms that a higher plant content of total free amino acids was obtained when salicylic acid was sprayed on the plants produced from sowing seeds at each of the experimented dates followed by spraying Glycine betaine while spraying naphthalene acetic confers a moderate impact. Nevertheless, all spray substances proved increment in total free amino acids content of snap bean plants compared to control plants. With concern the effect of seed sowing dates, data show also that sowing seeds on February1st surpassed sowing seeds on December 1st and January 1st for plant content of total free amino acids. Otherwise, the less free amino acids content was gained when seeds were sown on December 1st during both two seasons. It has been well known that cultivation the plant of-season submit it for inappropriate environmental conditions and lying certain stresses. These results are in the same line with the findings of Rai, (2002) , Hayat *et al*., (2012), Senthil *et al*., (2003), Ali *et al.* (2009), Heshmat *et al.,* (2012), Shokr (2014) and Balwinder *et al.,* (2014).

Table 6: Effect of sowing date and foliar application of some plant stimulants on total free amino acids content (mg/100g) of snap bean plants grown during 2011-2012 and 2012-2013 seasons.

Planting date	2011-2012				Mean	Planting date	2012-2013				Mean
	Foliar applications						Foliar applications				
	Cont.	GB	NAA	SA			Cont.	GB	NAA	SA	
Dec.	1.33 h	1.42 g	1.36 h	1.63 e	1.439 C	Dec.	1.38 g	1.52 f	1.39 g	1.63 e	1.509 C
Jan.	1.50 f	1.83 d	1.64 e	1.85 d	1.798 B	Jan.	1.632 e	1.77 d	1.65 e	1.79 d	1.695 B
Feb.	1.85 d	2.41 b	2.22 c	2.50 a	2.163 A	Feb.	1.82 d	2.23 b	2.09 c	2.61 a	2.185 A
Mean	1.65 D	1.84 B	1.80 C	1.89 A		Mean	1.61 D	1.88 B	1.66 C	2.02 A	

Means followed by the same letter are statistically not significant according Duncan's multiple range test (P=0.05).
Cont = Control GB = Glycine betaine NAA= Naphthalena acetic acid = SA = Salicylic acid
Dec. = December Jan. = January Feb. = February

Effect of seed sowing date and foliar application of some plant stimulants on photosynthetic pigments in pods:

In Table (7) the highest pigments content was shown in pods when seeds were sown on February1st accompanied by spraying plants with salicylic acid. In return, the less values of the pigments were recorded for pods produced from sowing seeds on December 1st and spraying plants with distilled water as

control. While sowing seeds in January, led to a slight enhancement of pods pigments content under all tested substances.

Table 7: Effect of sowing date and foliar application of some plant stimulants on chlorophyll a and b and charotioides (mg/100 g FW) of snap bean pods during 2011-2012 and 2012-2013 seasons.

planting date	2011-2012				Mean	planting date	2012-2013				Mean
	Foliar applications						Foliar applications				
	Cont.	GB	NAA	SA			Cont.	GB	NAA	SA	
Dec.	137.80 f	147.42 e	138.89 f	149.69 e	143.45 C	Dec.	142.86 h	150.24 g	145.49 h	153.27g	147.96 C
Jan.	165.38 d	173.36c	170.02cd	174.82 c	170.89 B	Jan.	172.87 f	178.28e	173.69f	181.52d	176.59 B
Feb.	185.18 b	200.28 a	188.94 b	203.84 a	194.56 A	Feb.	189.53 c	194.74ab	191.66 bc	197.32 a	1 93.31A
Mean	162.79 D	173.69 B	165.95 C	176.12 A		Mean	168.42 D	174.42 B	170.28C	177.37 A	
Chlorophyll b (mg/100 g FW)											
planting date	2011-2012				Mean	planting date	2012-2013				Mean
	Foliar applications						Foliar applications				
	Cont.	GB	NAA	SA			Cont.	GB	NAA	SA	
Dec.	71.24 g	81.51d e	76.98 f	84.76 e	78.62 C	Dec.	78.44 h	87.58 f	81.89 g	89.52f	84.36C
Jan.	82.82 e	91.09 c	85.89 d	91.41 c	87.30 B	Jan.	88.99 f	96.08d	92.02 e	98.16d	93.81B
Feb.	98.23 b	105.21 a	101.10 b	107.44 a	103.0 1 A		111.76 c	116.99a	114.54b	118.84 a	115.53A
Mean	84.10 D	92.12B	87.98C	94.34 A		Mean	93.06D	100.21B	96.15C	102.17 A	
Carotenoids (mg/100 g FW)											
Planting date	2011-2012				Mean	planting date	2012-2013				Mean
	Foliar applications						Foliar applications				
	Cont.	GB	NAA	SA			Cont.	GB	NAA	SA	
Dec.	54.60 j	62.24 i	57.71j	66.95h	60.37C	Dec.	60.84g	65.15f	62.15 g	68.24e	64.10C
Jan.	68.55gh	73.75ef	70.55fg	77.40cd	72.56B	Jan.	74.33d	78.80c	75.36 d	81.55c	77.51B
Feb.	74.20de	88.86b	79.96c	93.55a	84.14A	Feb.	86.88b	93.95a	88.41 b	95.56a	90.88A
Mean	65.78D	74.95B	69.41C	79.30A		Mean	74.02D	78.97B	76.31 C	83.68A	

Means followed by the same letter are statistically not significant according Duncan's multiple range test (P=0.05).
Cont = Control GB = Glycine betaine NAA =Naphthalena acetic acid = SA = Salicylic acid
Dec. = December Jan. = January Feb. = February

Generally, the data show that, salicylic acid spraying led to supreme effect on pods pigments content followed by spray with Glycine betaine but the less impact was found accompanied with spraying naphthalene acetic acid.

By reviewing our data, it has been noticed that there are a close relations between snap bean plant growth and green pods yield and quality. These relations are reflected in the experimental treatments which lead to a higher plant growth also lead to a higher yield and quality. Our results are consistent with those of Shaban, (2005), also on green gram Ananthi and Mallika (2013) and Shokr, (2014).

Conclusion

Finally, the obtained results from this work have concluded that extension of production period of green bean under open field conditions is possible based on climatic changes via sowing seeds during off-season on December 1st, January 1st and February 1st. Due to the worst temperature in such sowing dates occasionally, foliar spraying with plant stimulants as salicylic acid at rate 1 m M/L, Glycine betaine at rate 5 mM/Land naphthalene acetic acid at rate 20 ppm can mitigate the stress of low temperature. The best plant behavior and productivity were gained through sowing seeds on February 1st , the best plant stimulant substance efficiency was salicylic acid and the best impact on plant growth, yielding, and pods quality was for combining sowing date of February 1st and plant stimulant of salicylic acid.

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