



## RESPONSE OF SNAP BEAN PLANTS TO SOME AGRICULTURAL TREATMENTS FOR EARLY YIELD PRODUCTION

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### ABSTRACT

Two field experiments were carried out during two early summer seasons of 2012 and 2013 years at the Experimental Farm of Kaha Station, Qalubia Governorate to study the response of snap bean plants *Poulista c.v* to some agricultural treatments for early green pods yield production using (flowering, amcotone, super phosphate solution compounds) as foliar nutrition, (charcoal, agriculture sulphur and charcoal + agriculture sulphur) as soil addition and (Pea, onion and broad bean) as protection plants, in addition using black polyethylene plastic as a soil mulch. The results indicated that spraying the plants with flowering and amcotone compounds followed by super phosphate solution had the highest values of fresh and dry plant weight. While adding charcoal to the soil before sowing snap bean seeds gave the highest values of no. of leaves/ plant followed by spraying with flowering and amcotone compounds, respectively. The data showed also that spraying the plants with flowering, amcotone compounds, super phosphate solution, adding charcoal + sulphur and soil mulch with black polyethylene plastic exerted the highest values on all parameter of green pods its and yield attributes in both growing seasons. Concerning total sugars in dry pods it's clear that using protection plants with broad bean followed by onion were the best treatments on it. Generally it can recommend using any one of the mentioned treatments in this experiment especially flowering, amcotone compounds, super phosphate solution, charcoal + sulphur, respectively to obtain high green pod yield either early or total with the best quality.

### INTRODUCTION

Snap bean plants (*Phaseolus vulgaris L.*) are considered one of an important vegetable crops cultivated in Egypt for local market and exportation. It is known that, bean plants are relatively sensitive to environmental stresses specially high and low temperature, that may occur in the field which negatively affect its growth, yield and even the quality of pods. The optimum temperature range for optimum bean growth or pod yield is between 16- 30°C (Nonnecke, 1989). In addition, temperature below or above this range had deleterious effects on plant performance as well as green pod yield. Seeds germination perhaps failing or might be delaying at temperature below 10°C as found by Poincelot (1980). Many investigators indicated that bean plants are very sensitive to different environmental stresses such as chilling (El-Tohamy et al 2001, Singer et al 1996) drought (Millar and Gardner, 1972; Halterlein, 1983; El-Tohamy et al 1999) and heat stress Dale, (1964). Hence, improving tolerance of bean plants to the possible environmental stresses by using different treatments is important to enhance its growth, maximize the yield and its quality.

Flowering and Amcotone compounds contain Naphthyl acetic acid (NAA) and Naphthyl acetamide it is known that, NAA could activate membrane  $Ca^{2+}$ -ATP as activate better movement of Ca. Banuelos et al (1988) reported that transport of calcium in tomato fruit is concerned with the basipetal transport of auxins. Moreover, NAA has also played main role in transport of Ca in Chinese cabbage (Wen et al 1991). Dong et al (2005) also suggested that spraying  $CaCl_2$  in combination with NAA to tomato plants for better Ca mobilization. Higher level of  $CaCl_2$  (1%) with NAA (0.02%) increased plant growth and yield by improving mineral uptake of tomato plants. Suty (1984) showed that, foliar application on faba bean plants with

Rhodofix (NAA) increased yield. Moreover, **Bai et al (1987)** applied eight foliar sprays of 25 mg /L NAA at 7 days intervals on *Vigna radiata* led to significant increases in seed yield and yield components. **Shukla et al (1997)** on soybean and **Aslam et al (2010)** on chickpea concluded that spray of growth regulators enhanced the number of pods per plant, pod weight per plant and gave higher seed yield over the control. **Deotale et al (1998)** studied the effect of foliar spraying with GA and NAA on growth parameters of soybean and obtained highest values for plant height and number of leaves per plant with adding 100 mg/ L NAA.

Plant charcoal, or biochar, is considered pure carbon and it is useful as a soil additive for vegetables, flowers and potted plants. Biochar helps on allowing better uptake of nutrients and fertilizers added to the soil for vigor plants and greater yields of trees fruits, vegetables and blooms on plants. It is a manufactured product but is all natural and prepared from green waste products, such as tree trimmings. Biochar is a rich carbon product formed by the incomplete combustion of biomass, has been shown to improve soil quality and increase crop growth. Studies have shown significant increases in the availability of all major cations (**Glaser et al 2002 and Topoliantz et al 2005**). Moreover, **Graber et al (2010)** and **Altland and Locke (2012)** demonstrated that additions of biochar up to 10% by volume decreased peak nitrate and phosphate leaching by slowing their release over time. This suggests nitrate could be applied less frequently due to the capacity of biochar to hold nitrate and release it to the plant roots slowly.

Regarding to soil mulches at early spring plantation or in winter for early yields, it is known that black polyethylene plastic mulch is the standard plastic mulch used in vegetable production, the importance of usage polyethylene mulch is due to its benefits when covering soil surface before sowing to recognize greater benefits, i.e. increases soil temperature, especially in early spring, reduces weed problems, enhances moisture conservation, increases crop yields and leads to more efficient use of soil nutrients (**Berihun, 2011; Bhatt et al 2011; Hatami et al 2012; Kumar and Lai, 2012**).

Concerning using super phosphate solution it is known that, Phosphorus is absorbed in the form of phosphate ions,  $\text{H}_2\text{PO}_4^-$  and  $\text{HPO}_4^-$ . It is an essential constituent of lipo- protein membranes of cell, nucleoproteins, many co-enzymes and organic molecules such as ADP, ATP and NADP which play an important role in the energy transfer reactions of cell metabolism and in oxidation, reduction

reactions. (**Kochhar and Krishnamoorthy, 1988**). It is also necessary for the functioning of mitochondria, which are the centers of cellular respiration. **Shafeek et al (2005)** found that all parameters of plant growth, total yield and yield components as well as the chemical composition of green pea seeds tissues recorded the highest significant values with applying the chemical sources of phosphorus and potassium fertilizers compared with the natural source alone. Moreover, **El-Tohamy et al (2006)** indicated that additional foliar application of nutrients especially by phosphorus, calcium and potassium can improve growth and yield of pepper plants grown under sandy soil conditions during winter season, the reduction of the electrolyte leakage in response to foliar application of P, Ca and K during low temperature conditions could be an indirect effect on reducing plant tissue dehydration caused by chilling which resulted in higher plasma membrane stability.

Regarding to sulphur, it has an important role in the formation of plant proteins and some hormones, as well as being necessary for enzymatic action, chlorophyll formation, and synthesis of certain amino acids and vitamins (**Kundu and Gaur, 1984 and Monib et al 1984**). Hence, sulphur is important for good vegetative growth leading to a high yield and increasing absorption of macro and micronutrients. This is through its oxidation to sulphuric acid by soil microorganisms leading to the solubilization and availability of nutrients to plants crops. (**Marschner, 1998; Salem, 2003 and Salem et al 2004**).

It is obvious that, sowing bean plants under the protection methods with maize and sunflowers **Turky (2007)** and **Abdel-Aziz and Gaafer (2013)**, cowpea and maize **Dahmardeh et al (2010)** and **Eskandari et al (2012)** as protection plants significantly increases in growth characteristics, pod yield and some chemical properties i.e. nitrogen, phosphorus and potassium (%) when compared with the control unprotected plant.

Therefore, the aim of this investigation was to study the response of snap bean plants grown in early summer season to some agricultural treatments for obtained early green pod yield with the best quality.

## MATERIALS AND METHODS

The present work was carried out during two early summer successive seasons of 2012 and 2013 at the Experimental Farm, Kaha Station,

Qalubia Governorate. Soil was clay in texture with 7.2 ph, 3.5 EC 1.15% organic matters, 110 ppm N, 49 ppm P and 103 ppm K. Seeds of snap bean cv . Poulista were obtained from Horticultural Research Institute, Agriculture Research Center, Egypt .The climatic condition ,i.e. temperature and relative humidity during plantation period are shown in **Table (1)**.

The experiment was carried out in complete randomized block design with three replicates. The seeds of snap bean were sown on January 8<sup>th</sup> and 2<sup>nd</sup> in 2012 and 2013, respectively in hills on one side of ridges at 7 cm spaces. The area of each experimental plot was 8.4m <sup>2</sup>and consisted of 3 ridges (4m long with 0.70m width).

The experiment contained eleven treatments as the following:

- T1- Control
- T2 - Flowering T3- Amcotone T4- Super phosphate solution (T2, T3and T4) as foliar nutrition.
- T5- Pea T6- Onion T7- Broad bean (T5, T6 and T7) as plant protection.
- T8- Black Polyethylene plastic mulch (BP Mulch). As soil mulch.
- T9 - Charcoal (3 t /fed)
- T10- Agriculture sulphur (250kg/fed)
- T11- Charcoal + agriculture sulphur with the same rates (T9, T10 and T11) as soil application.

Compounds (flowering, amcotone, super phosphate solution) were used as foliar nutrition for the purpose of enhancing pod setting and for cold tolerant. Plants were sprayed three times with aqueous solution of the used materials, the first spray was conducted at the three true leaves stage, whereas the second and third spray were performed 10 days intervals. Pea, onion and broad bean were sown on the other side of ridge as protection plants. Charcoal and agriculture sulphur were mixed with the soil before sowing during soil preparation.

**Table 1.** Climatic condition at the experimental sites during periods of studies (Central Laboratory for Agricultural Climatic)

Month	Temperature(C°)		Relative humidity %	Month	Temperature(C°)		Relative Humidity %
	Minimum	Maximum			2013	Maximum	
2012				2013			
January	1.48	21.93	75	January	0.74	24.81	77
February	3.37	20.74	69	February	1.74	26.26	75
March	0.63	24.98	71	March	2.23	35.27	70
April	7.18	37.72	66	April	6.1	36.82	65
May	11.8	38.54	62	May	11.47	40.75	59

**Table 2.** Spray compounds and its contents of the foliar nutrition compounds used in this study

Compounds name	Composition	Concentration
Flowering	Naphthyl acetic acid 1.5%, Naphthyl acetamide 0.3% and other additives 97.9%	0.5 g/ liter
Amcotone	Naphthyl acetic acid 0.45%, Naphthyl acetamide 1.25% and other additives 98.3%	0.6 g/ liter
Super phosphate	15.5% P <sub>2</sub> O <sub>5</sub>	3 g/ liter after socking 24 hours

## Data Recorded

### I- Plant Growth Measurements

Representatives samples of 3 plants were taken by random 70 days after sowing (at flowering stage), from each experimental plot for measuring the plant growth characters, as follows:

Plant length (cm), number of leaves plants, total fresh weight and dry weight of plant (determined at 65°C for 72 hours using the standard methods as illustrated by **A.O.A.C. (1990)**.

### II- Green Pod Yield and its attributes

Random samples of 10 green pods at the second picking were taken (after 85 days from sowing) to determine the following data:

- Average pod length (cm), Pod diameter (cm), Average fresh pod weight (g) and Average dry pod weight (g).
- Early pod yield ton/fed as the first and second pickings (after 77-85 days from sowing) -Total pod yield ton/fed as the total pickings.

### III- Chemical properties

#### The following measurements were determined:

Total leaf chlorophyll was measured using Minolta chlorophyll Meter SPAD- 501 as SPAD units.

**Total protein%** : It was determined as nitrogen content of pod and converted to its equivalent protein content by multiplying N content x 6.25 (**A.O.A.C.1990**)

Total nitrogen, phosphorus and potassium were determined in dry pods on the basis of dry weight according to the methods described by **Bremner and Mulvaney (1982)**, **Olsen and Sommers (1982)** and **Jackson (1967)**, respectively.

**Total sugars:** It was determined on the basis of pod dry matter, calorimetrically using spectrophotometer with the phenol sulphuric acid method described by **Dubois et al (1975)**

**Statistical Analysis:** All data were subjected to statistical analysis according to the procedures reported by **Snedecor and Cochran (1982)** using M. stat program and means were compared by L.S.D multiple range tests at the 5% level of probability in the two seasons of experimentation.

## RESULTS AND DISCUSSION

### I- Plant Growth Measurements

Results of **Table (3)** illustrated that, spraying of flowering or amcotone compounds followed by the treatment of super phosphate solution had the highest values of fresh and dry plant weight. While, adding charcoal to the soil before sowing snap bean seeds gave the highest values of no. of leaves/ plant followed by spraying of flowering and amcotone compounds, respectively. Regarding to plant length, data indicated that treatments used in this study did not induce any significant effect in both growing seasons. It is clear that, the lowest values of vegetative growth parameters of snap bean plants were recorded by the control treatment. These results are in agreement with those obtained by **Dong et al (2005)** on tomato, they indicated that higher level of CaCl<sub>2</sub> (1%) or NAA (0.02%) increased plant growth by improving minerals uptake of tomato plants. Moreover, **Deotale et al (1998)** on soybean studied the effect of GA and NAA on growth parameter of soybean and they obtained the highest values of plant height and number of leaves per plant by 100 mg/ L NAA treatment. Charcoal has been shown to improve soil quality and increase crop growth in addition; the studies have shown significant increases in the availability of all major cations as mentioned by (**Glaser et al 2002 and Topoliantz et al 2005**). On the other hand, **El-Tohamy et al (2006)** indicated that additional foliar application of nutrients especially by phosphorus, calcium and potassium can improve growth of pepper plants.

Regarding using the plant protection treatments with broad bean, pea and onion, it is clear that these treatments did not show significant effect on both parameters of plant growth as shown in **Table (3)**. On the contrary, using black polyethylene mulch led to significant increase on fresh and dry weight of snap bean plant during the two seasons as shown in **Table (3)**. It is known that using plastic mulch induce many benefits for plant growth by the way of increases soil temperature, especially in early spring, reduces weed problems, enhances moisture conservation, increases crop yields and leads to more efficient use of soil nutrients (**Berihun, 2011; Bhatt et al 2011; Hatami et al 2012; Kumar and Lai, 2012**).

### II- Green pod yield and its attributes

The data in **Table (4)** showed that spraying snap bean plants with flowering, amcotone compounds, super phosphate solution, as well as

**Table 3.** Effect of some agricultural treatments on vegetative growth of snap bean plants during the two seasons of 2012 and 2013

Treatments	Plant length (cm)		No. of. leaves / plant		Fresh weight (g/plant)		Dry weight (g/plant)	
	2012	2013	2012	2013	2012	2013	2012	2013
Control	17.75	14.16	11.50	8.67	19.26	16.96	2.95	3.33
Flowering	24.66	22.16	17.50	15.50	35.38	32.76	6.78	6.45
Amcotone	24.16	22.00	17.22	14.00	33.53	31.16	7.31	6.61
Super phosphate	21.75	20.50	14.25	12.75	30.50	29.55	6.50	5.51
Mulch	20.66	23.66	14.00	15.00	28.01	29.21	5.50	5.85
Pea	19.87	19.87	13.75	12.00	23.25	22.92	4.55	4.32
Onion	20.25	18.56	15.25	12.33	24.87	26.20	4.61	4.37
Broad bean	19.83	18.16	13.00	14.17	24.65	23.12	4.12	4.10
Charcoal	21.16	17.66	19.33	11.61	26.71	24.91	6.31	4.30
Sulphur	21.16	19.33	14.39	13.00	27.65	23.98	6.32	4.95
charcoal + sulphur	23.00	20.50	13.44	13.37	26.79	23.49	6.40	5.08
L.S.D at 5%	N.S	N.S	4.25	N.S	7.35	3.95	2.05	1.24

**Table 4.** Effect of some agricultural treatments on green pod yield and its attributes of snap bean plants during the two seasons of 2012 and 2013

Treatments	Pod length (cm)		Pod diameter (cm)		Fresh pod weight (g)		Dry pod weight (g)		Early yield (ton/fed)		Total yield (ton/fed)	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
Control	10.04	9.87	0.63	0.62	2.47	2.36	0.25	0.24	0.84	0.90	1.69	1.40
Flowering	11.80	12.55	0.65	0.66	4.08	4.46	0.33	0.34	1.90	1.80	3.83	3.63
Amcotone	11.78	11.68	0.64	0.65	3.80	3.84	0.35	0.33	1.80	1.76	3.61	3.44
Super phosphate	11.61	11.00	0.65	0.63	3.60	3.68	0.33	0.30	1.81	1.66	3.57	3.24
Mulch	11.47	11.93	0.63	0.64	3.53	4.04	0.32	0.32	1.55	1.62	3.01	3.12
Pea	10.84	11.06	0.63	0.64	3.22	3.37	0.32	0.31	1.67	1.18	2.86	3.01
Onion	10.75	11.01	0.62	0.63	3.27	3.57	0.29	0.28	1.46	1.39	3.00	3.05
Broad bean	10.42	10.54	0.63	0.63	3.06	3.13	0.27	0.26	1.02	1.13	2.39	2.37
Charcoal	11.15	10.74	0.63	0.61	3.39	3.33	0.30	0.31	1.38	1.27	3.03	3.07
Sulphur	11.16	11.31	0.63	0.64	3.45	3.36	0.31	0.31	1.61	1.55	3.16	2.93
charcoal + sulphur	11.21	11.43	0.63	0.67	3.54	3.67	0.33	0.32	1.70	1.59	3.19	3.11
L.S.D at 5%	0.80	0.74	0.05	N.S	0.62	0.42	0.05	N.S	0.34	0.28	0.67	0.72

adding charcoal + sulphur and mulching with black polyethylene plastic exerted the highest values of all parameter of yield and yield attributes in both growing seasons. On the contrary, the lowest early and total yield of snap bean were recorded by the control treatment. These results are in agreements with those obtained by **Suty (1984)** on faba bean, **Bai et al (1987)** on *Vigna radiata*, **Shukla et al (1997)** on soybean and **Aslam et al (2010)** on chickpea. They concluded that spraying growth regulators enhanced number of pods per plant, pod weight per plant and gave higher seed yield over the control. **Shafeek et al (2005)** found that total yield and yield components of pea recorded the highest significant values with applying the mineral sources of phosphorus and potassium fertilizers compared with the natural source alone. Moreover, **El-Tohamy et al (2006)** indicated that using foliar application of nutrients especially by phosphorus, calcium and potassium can improve yield of pepper plants grown under sandy soil conditions during winter season.

Regarding to soil mulch treatment ,it was obvious that, the increase in pod yield by usage polyethylene mulch is due to its benefits when using soil covering i.e. increases soil temperature, especially in early spring, reduces weed problems, enhances moisture conservation, increases crop yields and leads to more efficient use of soil nutrients (**Berihun, 2011; Bhatt et al 2011; Hatami et al 2012; Kumar and Lal, 2012**). On the other hand, sulphur is important for good vegetative growth leading to a high yield and increasing absorption of macro and micronutrients. This is through its oxidation to sulphuric acid by soil

microorganisms leading to the solubilization and availability of nutrients to plants crops. (**Marschner, 1998; Salem, 2003 and Salem et al 2004**).

### III- Chemical properties

Data in **Table (5)** show that adding charcoal to the soil before sowing snap bean seeds followed by adding charcoal + sulphur treatment produced pods contained the highest values of protein and N percentage. Concerning total sugars it's clear that using protection plants by broad bean followed by onion were the best treatments. This result are in agreement with those mentioned by **Abdel-Aziz and Gaafer (2013); Dahmardeh et al (2010) and Eskandari et al (2012)**. These results may be due to that charcoal helps and allow better uptake of nutrients and fertilizers added to the soil. Studies have shown significant increases in the availability of all major cations as mention by **Glaser et al (2002), Topoliantz et al (2005), Graber et al (2010) and Altland and Locke (2012)**. While, plants sprayed with amcotone compound gave the highest values of P% and K%, in both growing seasons. Regarding to total chlorophyll of leaves, data indicated that, there was no significant effect from using all treatments in both growing seasons. According to agriculture sulphur, it is known that sulphur has an important role in the formation of plant proteins and some hormones, as well as being necessary for enzymatic action, chlorophyll formation, and synthesis of certain amino acids and vitamins (**Kundu and Gaur, 1984 and Monib et al 1984**).

**Table 5.** Effect of some agricultural treatments on pod chemical properties and leaf chlorophyll content of snap bean plants during the two seasons of 2012 and 2013

Treatments	Total Sugars %		Protein %		N%		P%		K%		Leaf chlorophyll (SPAD)	
	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
Control	7.80	8.20	11.81	12.56	1.89	2.01	0.42	0.45	2.15	2.18	39.83	35.16
Flowering	11.44	11.66	14.00	13.78	2.24	2.20	0.56	0.59	2.39	2.41	47.53	46.10
Amcotone	12.42	12.86	14.88	14.44	2.38	2.31	0.63	0.62	2.49	2.52	48.00	45.03
Super phosphate	10.84	11.06	15.09	15.12	2.41	2.42	0.61	0.61	2.31	2.36	49.26	43.55
Mulch	10.52	10.68	14.21	13.56	2.27	2.17	0.59	0.58	2.24	2.39	45.03	43.05
Pea	12.26	11.63	14.44	14.00	2.31	2.24	0.55	0.56	2.26	2.27	45.50	41.53
Onion	12.51	12.04	12.90	13.56	2.06	2.17	0.55	0.53	2.31	2.35	45.16	41.98
Broad bean	13.03	13.41	12.69	13.14	2.03	2.10	0.56	0.60	2.33	2.36	44.83	41.00
Charcoal	10.86	10.91	16.18	15.75	2.59	2.52	0.56	0.56	2.21	2.20	45.23	39.80
Sulphur	11.01	11.05	15.53	15.31	2.48	2.45	0.58	0.56	2.18	2.24	47.18	38.35
charcoal+sulphur	11.41	7.97	15.75	15.75	2.52	2.52	0.58	0.57	2.23	2.27	47.66	41.10
L.S.D at 5%	0.55	N.S	0.88	1.17	0.17	N.S	0.07	0.09	0.16	0.15	N.S	N.S

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