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Growth and Productivity of Two Cabbage Cultivars Grown in Sandy Soil as Affected by Foliar Spray with Npk Fertilizer and Amino Acids

Samar A. Bardisi¹; H. G. Zyada¹ and Manal A. Mandour²

¹Hort. Dept., Fac. Agric., Zagazig University, Egypt

²Central Lab. of Organic Agric., Agric. Res. Cent., Giza, Egypt



ABSTRACT

The present work was carried out at Private Farm (The Experimental Farm of Sand Valley Company) at Ismailia, Ismailia Governorate, Egypt during 2017/2018 and 2018/2019 seasons to study the effect of foliar spray with NPK (15-15-15) fertilizer at 1 or 2 ml/l and amino acids at 1.5 or 3 ml/l on two cabbage cultivars (OS Cross and Landini) grown under sandy soil conditions. The interaction between OS Cross cultivar and spraying with amino acids at 3 ml/l and NPK (15-15-15) fertilizer at 2 ml/l increased fresh weight of roots and stem, number of leaves/head and fresh weight of outer and inner leaves/head, head yield/plant, total head yield/fed and head diameter and circumference, followed by the interaction between OS Cross cultivar and spraying with amino acids at 1.5 ml/l and NPK (15-15-15) fertilizer at 1 ml/l with no significant differences with the interaction between Landini cultivar and spraying with amino acids at 3 ml/l and NPK (15-15-15) fertilizer at 2 ml/l with respect to number of leaves/head.

Keywords: White cabbage, OS Cross and landini cultivars, amino acids, NPK, head yield.

INTRODUCTION

Cabbage (*Brassica oleraceae* var. *capitata* L.) is one of Egypt's most popular and commonly grown cruciferous winter leafy vegetables. It is rich in vitamins A, B1, B2 and C (Singh *et al.*, 2010) It is also a rich source of essential amino acids and other antioxidant compounds, as it is abundant in certain substances with a high antioxidant potential, such as vitamin C (ascorbic acid), carotenoids and polyphenols (Leja *et al.*, 2007). The total area devoted to production in Egypt in 2018 was 41400 fed, generating 525410 tons with an average of 12,691 tonnes / fed. (FAO, 2019)

OS Cross is a large hybrid cabbage, bolt-resistant plant, bursting and heat-tolerant, preferring warm, moist soil and plenty of full sunlight for best growth. Landini hybrid cabbage is suited to different climates, appropriate for fresh market and well-standing processing, resistant to cracking, high fusarium resistance and stable growth even in hot weather.

Olaniyi and Ojetayo (2011) It was found that the growth parameters and yield of cabbage attributes were significantly affected by the types and variety of fertilizers and, at 12 weeks after planting, the Copenhagen market had a mean number of plant leaves, height and yield higher than that of F1 Milor. Cabbage cv.

OS Cross had the highest leaf / plant number, head diameter, head weight, dry matter percentage and yield compared to Nabrawy cultivar (El Sagan, 2014)

Being a powerful root system, the cabbage extracts vast quantities of nutrients that go into head formation. Cultivation of cod plants therefore requires high soil fertility with good fertilization and foliar spray with NPK fertilizers. Nutrient foliar application removes problems such as trapping and immobilisation. Due to high solubility, simple and fast absorption by plant tissues, foliar application of water-soluble

fertilizers is considered highly suitable for growing the cabbage head yield. These fertilizers have specific N, P, and K ratios with high water solubility and are also ideal for foliar feeding (Jeyabal *et al.*1998).

Olaniyi and Ojetayo (2011) found the highest growth parameters (number of leaves and plant height) were obtained from plant received NPK 15-15-15 in F1 Milor. Moyin-Jesu1 (2015) reported that the application of NPK 15-15-15 fertilizer significantly increased the cabbage head yield and growth parameters compared to control. Foliar applications of cabbage with NPK at different ratios increased plant height, number of branches compared to control and head yield (Atanasova *et al.*, 2007 and Narayan *et al.*, 2016)

Traditionally, amino acids were used as precursors and protein constituents. Many amino acids often serve as precursors to other compounded nitrogen, e.g., nucleic acids. Among plants, amino acids can play significant roles including functioning as regulatory and signaling molecules. Amino acids also influence some enzyme synthesis and function, gene expression and redox homeostasis (Rai, 2002).

Amino acids are a well-known stimulant that has beneficial effects on plant growth, yield and significantly mitigates abiotic stress-induced injuries. An essential quantity of amino acids is also well known as a means has positive effects on plant production, yield and quality of various crops. Amino acids are important ingredients in protein synthesis process; plant tissue formation and chlorophyll synthesis (Kowalczyk and Zielony, 2008).

Many studies have reported that foliar application of amino acids caused an increase in the growth and development of plants. El-Afifi *et al.* (2014) found that foliar spray with amino acid at 2 ml/l caused highly significant increases in stem diameter, whole stem weight, number of total leaves/ plant, weights of outer leaves (inedible), inner

* Corresponding author.

E-mail address: mr.mramadan317@yahoo.com

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leaves (edible) and total leaves/ plant, fresh weights of total yield (whole head) and marketable yield (edible head) of Chinese cabbage compared to the control (unsprayed) treatment in both seasons). The increase (%) in weights of total and marketable yield resulted from foliar spray with amino acid over no spray were 43.3 and 14.8 (%) as av. two seasons. Mohamed and Zewail (2016) revealed that spraying with amino acids at 2 ml/l increased plant height, stem length, number of leaves / plant, number of outer and inner leaves / plant, head fresh weight, stem fresh weight, plant fresh weight, head diameter and circumference of cabbage cv Balady compared to control (spraying with normal water).

Foliar spray of white cabbage cultivars (medium early Chopin F1 and medium late Landini F1) grown under field conditions 6 times with Pentakeep -V fertilizer (at 0.5 kg/ha) contained the bio-stimulator ALA (5-aminolevulinic acid) and different contents of macro and micro-elements (9.5% N, 5.7% MgO, 0.3% Mn, 0.45% B with micro-elements Fe, Zn, S, Cu and Mo) had a positive effect on development, yield, marketable yield and average head weight in comparison to the control plants which received a standard fertilization. The increase in the marketable yield varied from 8.6% to 9.7% and an average head weight from 8.6% to 8.9%. (Babik et al., 2008).

Therefore, the objective of the work was to study the effect of foliar spray with NPK (15-15-15) fertilizer and amino acids on two cabbage cultivars grown under sandy soil conditions.

MATERIALS AND METHODS

The present work was carried out at Private Farm (The Experimental Farm of Sand Valley Company) at Ismailia, Ismailia Governorate, Egypt during 2017 / 2018 and 2018 / 2019 seasons to study the effect of foliar spray with amino acids and NPK (15-15-15) fertilizer on growth and yield of two cabbage cultivars grown under sandy soil conditions using drip irrigation system.

Soil chemical analysis was applied using the method described by Black (1982). The experimental soil was sandy in texture with drip irrigation system. The soil chemical properties were: organic matter 0.07 and 0.09%; available N 14.62 and 14.98 (ppm); available P 18.0 and 19.46 (ppm); available K 59.6 and 63.1 (ppm); pH 7.90 and 7.88 and E.C. 2.10 and 2.50 mmhos /cm in the first and second seasons, respectively.

This experiment included 14 treatments which were the combinations between two cabbage cultivars (OS Cross and Landini) and seven foliar spray treatments of NPK (15-15-15) fertilizer and amino acids treatments, i.e. spraying with amino acids at 1.5 and 3 ml/l and NPK (15-15-15) fertilizer at 1 and 2 ml/l as well as control (spraying with tap water).

These treatments were arranged in a split plot in a complete randomized block design with three replicates. Hybrids were randomly arranged in the main plots amino acids and NPK (15-15-15) fertilizer were randomly distributed in the sub plots.

The seeds of two cabbage cultivars were sown on 20th and 15th December in speeding trays in the 1st and 2nd seasons, respectively. Transplants were transplanted on 20th and 15th January. in the 1st and 2nd seasons, respectively on dripper line with 0.9 m width and 12 m length with 0.8 m apart between

each plant and plot inclusive one dripper line. Plot area was 10.8 m². The source of seeds cultivars (OS Cross and Landini) was Sand Valley Company, Ismailia, Egypt. The source of NPK(15-15-15) fertilizer (Super grow) and amino acids (Amino grow at 25%) was Hasad El-Zahab Company for fertilizers, Saudi Arabia, imported Sand Valley Company, Ismailia, Egypt. Amino acids (Amino grow contains 20% botanical free amino acids, 7% N, 1000 ppm Fe, 750 ppm Mn, 350 ppm B, 200 ppm Zn, and 200 ppm Cu) and NPK (15-15-15) fertilizer (Super grow contains NPK at 15%, 15% and 15%, respectively supplemented with chelated micro elements) were sprayed at 50, 65 and 80 days after transplanting. Each plot received 3L of NPK (15-15-15) fertilizer and amino acids solutions using spreading agent (reflecting materials). The control plants (check) were sprayed with tap water and spreading agent only.

All plants received ammonium sulphate (20.5% N) applied at rate of 300 kg/fed. and potassium sulphate (48% K₂O) at rate of 150 kg/fed. were applied. Calcium superphosphate (16% P₂O₅) at rate of 350 kg/fed. was added during soil preparation. Nitrogen and potassium quantities were divided into three doses and applied within drip irrigation system starting at 30 days after transplanting until the end of the season. All the plants were received normal agricultural practices whenever they were needed.

Data recorded

Plant growth:

The heads of cabbage were harvested (at 90 days after transplanting) in both seasons and the following data were recorded: Fresh weight of roots (g/plant), fresh weight of stem (g/plant), number of leaves / plant, fresh weight of outer leaves (g/plant) and fresh weight of inner leaves (g/plant).

Head yield / plant and total head yield per feddan:

The heads of cabbage were harvested and the head yield/ plant was determined as whole heads (outer and inner leaves and stem) of each plot were weighed in g and converted to estimate in ton per feddan.

Head quality:

It was determined for five cabbage plants were randomly taken from each plot at harvesting and the following data were recorded: Head diameter (cm) and head circumference (cm).

Statistical analysis:

All the obtained data were statistically analysis using the COSTAT program and means separation were done by least significant value (L.S.D.) at 0.05 level of probability according to Snedecor and Cochran (1980).

RESULTS AND DISCUSSION

1. Plant Growth

Fresh weight of roots and stem

Obtained results in Tables 1 and 2 show that there were significant differences between OS Cross and Landini cultivars in fresh weight of roots and stem / plant in both seasons. OS Cross gave higher fresh weight of roots and stems than Landini cultivar.

Spraying cabbage plants with amino acids at 1.5 and 3 ml/l and NPK (15-15-15) fertilizer at 1 and 2 ml / l increased fresh weight of roots and stem / plant compared to control (spraying with tap water). The interaction between OS Cross cultivar and spraying with amino acids at 3 ml/l

and NPK (15-15-15) fertilizer at 2 ml / 1 gave higher values between OS Cross cultivar and spraying with amino acids at 1.5 ml/l and NPK (15-15-15) fertilizer at 1 ml / 1.

Table 1. Effect of cultivars, foliar spray with amino acids and NPK rates and their interaction on root fresh weight (g) of cabbage plant during 2017 / 2018 and 2018 / 2019 seasons

Amino acids and NPK (15:15:15) rates (T)								
Cabbage cultivars (cvs)	Tap water	Amino acid (1.5 ml/l)	NPK (1ml/l)	Amino acid (3 ml/l)	NPK (2ml/l)	Amino acid (1.5 ml/l)+ NPK (1ml/l)	Amino acid (3 ml/l)+ NPK (2ml/l)	Mean (CVS)
2017 / 2018 season								
OS Cross	54.0	74.0	73.0	70.0	78.0	74.0	79.0	71.71
Landini	50.0	62.0	66.0	65.0	69.0	67.0	71.0	64.29
Mean (T)	52.0	68.0	69.5	67.5	73.5	70.5	75.0	--
LSD at 0.05 level	CVS = 2.18		T = 1.14		CVS x T = 1.62			
2018 / 2019 season								
OS Cross	50.0	64.0	69.0	72.0	81.0	84.0	88.0	72.57
Landini	38.6	62.0	66.0	68.0	71.0	72.0	75.0	64.66
Mean (T)	44.3	63.0	67.5	70.0	76.0	78.0	81.5	--
LSD at 0.05 level	CVS = 1.87		T = 2.09		CVS x T = 2.97			

Table 2. Effect of cultivars, foliar spray with amino acids and NPK rates and their interaction on stem weight (g) of cabbage plant during 2017 / 2018 and 2018 / 2019 seasons

Amino acids and NPK (15:15:15) rates (T)								
Cabbage cultivars (cvs)	Tap water	Amino acid (1.5 ml/l)	NPK (1ml/l)	Amino acid (3 ml/l)	NPK (2ml/l)	Amino acid (1.5 ml/l)+ NPK (1ml/l)	Amino acid (3 ml/l)+ NPK (2ml/l)	Mean (CVS)
2017 / 2018 season								
OS Cross	94.0	152.0	158.0	186.0	218.0	251.0	268.0	189.57
Landini	87.0	139.0	150.0	175.0	174.0	196.0	195.0	159.43
Mean (T)	90.50	145.50	154.00	180.50	196.00	223.50	231.50	--
LSD at 0.05 level	CVS = 3.21		T = 2.94		CVS x T = 4.17			
2018 / 2019 season								
OS Cross	104.0	147.0	161.0	176.0	210.0	231.0	248.0	182.43
Landini	97.0	124.0	132.0	160.0	171.0	184.0	190.0	151.14
Mean (T)	100.50	135.50	146.50	168.00	190.50	207.50	219.00	--
LSD at 0.05 level	CVS = 2.69		T = 1.74		CVS x T = 2.47			

Number of leaves / head

There were significant differences between OS Cross and Landini cultivars in number of leaves / head in both seasons and OS Cross cultivar recorded maximum number of leaves / head (Table 3).

Spraying cabbage plants with amino acids and NPK (15-15-15) fertilizer at different levels increased number of leaves / head compared to spraying with tap water (control) and spraying with amino acids at 3 ml/l and NPK (15-15-15) fertilizer at 2 ml / 1 gave the highest values of number of

leaves / head , followed by followed by spraying with amino acid at 1.5 ml/l and NPK (15-15-15) fertilizer at 1 ml / 1.

The interaction between OS Cross or Landini cultivar and spraying with amino acids at 3 ml/l and NPK (15-15-15) fertilizer at 2 ml / 1 gave the highest values of number of leaves / head with no significant differences with the interaction between OS Cross cultivar and spraying with amino acids at 1.5 ml/l and NPK (15-15-15) fertilizer at 1 ml / 1. Head diameter (cm) was positively correlated with number of leaves per head (El Sagan , 2014).

Table 3. Effect of cultivars, foliar spray with amino acids and NPK rates and their interaction on number of leaves/head of cabbage plant during 2017 / 2018 and 2018 / 2019 seasons

Amino acids and NPK (15:15:15) rates (T)								
Cabbage cultivars (cvs)	Tap water	Amino acid (1.5 ml/l)	NPK (1ml/l)	Amino acid (3 ml/l)	NPK (2ml/l)	Amino acid (1.5 ml/l)+ NPK (1ml/l)	Amino acid (3 ml/l)+ NPK (2ml/l)	Mean (CVS)
2017 / 2018 season								
OS Cross	20.0	23.0	23.0	25.0	26.0	29.0	29.0	25.00
Landini	17.0	22.0	23.0	25.0	25.0	26.0	27.0	23.57
Mean (T)	18.50	22.50	23.00	25.00	25.50	27.50	28.00	--
LSD at 0.05 level	CVS = 1.24		T = 1.72		CVS x T = 2.44			
2018 / 2019 season								
OS Cross	18.0	24.0	25.0	25.0	27.0	29.0	30.0	25.43
Landini	16.0	22.0	23.0	25.0	25.0	26.0	29.0	23.71
Mean (T)	17.00	23.00	24.00	25.00	26.00	27.50	29.50	--
LSD at 0.05 level	CVS = 1.47		T = 1.51		CVS x T = 2.14			

Fresh weight of outer and inner leaves

Data in Table 4 and 5 indicate that there were significant differences between OS Cross and Landini cultivars in fresh weight of outer and inner leaves and OS Cross cultivar recorded higher fresh weight of outer and

inner leaves / head compared to Landini cultivar in both seasons.

Spraying cabbage plants with amino acids at 1.5 or 3 ml/l and NPK (15-15-15) fertilizer at 1 or 2 ml / 1 increased fresh weight of outer and inner leaves / head compared to control (spraying with tap water) and spraying

with amino acids at 3 ml/l and NPK (15-15-15) fertilizer at 2 ml / l gave the highest fresh weight of outer and inner leaves /head.

The interaction between OS Cross cultivar and spraying with amino acids at 1.5 ml/l and NPK (15-15-15) fertilizer at 1 ml / l or with NPK (15-15-15) fertilizer at 2 ml / l increased fresh weight of outer and inner leaves / head in the 1st season , whereas in the 2nd season, the interaction between OS Cross cultivar and spraying with amino acids at 3 ml/l and NPK (15-15-15) fertilizer at 2 ml / l increased fresh weight of outer and inner leaves / head.

From the foregoing results , it could be concluded that , cabbage OS Cross grown in sandy soil recorded higher fresh weight of roots and stem , number of leaves / head and fresh weight of outer and inner leaves / head. . Differences between cultivars could be due to genetic differences.

Spraying cabbage plants with amino acids and NPK (15-15-15) fertilizer only or in combinations increased fresh

weight of roots and stem, number of leaves / head and fresh weight of outer and inner leaves / head compared to control (spraying with tap water) and foliar spray with amino acids at 3 ml/l and NPK (15-15-15) fertilizer at 2 ml / l gave the highest values increased these traits , followed by spraying with amino acids at 1.5 ml/l and NPK (15-15-15) fertilizer at 1 ml / l.

The interaction between OS Cross cultivar and spraying with amino acids at 3 ml/l and NPK (15-15-15) fertilizer at 2 ml / l increased fresh weight of roots and stem, number of leaves / head and fresh weight of outer and inner leaves / head, followed by the interaction between OS Cross cultivar and spraying with amino acids at 1.5 ml/l and NPK (15-15-15) fertilizer at 1 ml / l with no significant differences with the interaction between Landini cultivar and spraying with amino acids at 3 ml/l and NPK (15-15-15) fertilizer at 2 ml / l with respect to number of leaves / head.

Table 4. Effect of cultivars, foliar spray with amino acids and NPK rates and their interaction on outer leaves weight (g) of cabbage plant during 2017 / 2018 and 2018 / 2019 seasons

Cabbage cultivars (cvs)	Tap water	Amino acids and NPK (15:15:15) rates (T)						Mean (CVS)
		Amino acid (1.5 ml/l)	NPK (1ml/l)	Amino acid (3 ml/l)	NPK (2ml/l)	Amino acid (1.5 ml/l)+ NPK (1ml/l)	Amino acid (3 ml/l)+ NPK (2ml/l)	
2017 / 20 18 season								
OS Cross	1246.0	1466.0	1760.0	2252.0	2409.0	2420.0	2357.0	1987.14
Landini	1225.0	1323.0	1675.0	1933.0	1860.0	2150.0	2300.0	1780.86
Mean (T)	1235.50	1394.50	1717.50	2092.50	2134.50	2285.00	2328.50	---
LSD at 0.05 level	CVS = 26.45		T=17.36		CVS x T = 24.5 6			
2018 / 20 19 season								
OS Cross	1150.0	1496.0	1782.0	2130.0	2317.0	2455.0	2642.0	1996.00
Landini	1014.0	1300.0	1575.0	1833.0	1811.0	2050.0	2200.0	1683.29
Mean (T)	1082.00	1398.00	1678.50	1981.50	2064.00	2252.50	2421.00	---
LSD at 0.05 level	CVS = 32.65		T=36.18		CVS x T = 51.18			

Table 5. Effect of cultivars, amino acids and NPK rates and their interaction on Inner leaves weight (g) of cabbage plant during 2017/ 2018 and 2018 / 2019 seasons

Cabbage cultivars (cvs)	Tap water	Amino acids and NPK (15:15:15) rates (T)						Mean (CVS)
		Amino acid (1.5 ml/l)	NPK (1ml/l)	Amino acid (3 ml/l)	NPK (2ml/l)	Amino acid (1.5 ml/l)+ NPK (1ml/l)	Amino acid (3 ml/l)+ NPK (2ml/l)	
2017 / 20 18 season								
OS Cross	1651.0	2396.0	2394.0	2935.0	2750.0	2909.0	3765.0	2685.71
Landini	1632.0	2125.0	2029.0	2675.0	2554.0	2411.0	2931.0	2336.71
Mean (T)	1641.50	2260.50	2211.50	2805.00	2652.00	2660.00	3348.00	--
LSD at 0.05 level	CVS = 42.18		T=36.39		CVS xT= 51.48			
2018 / 20 19 season								
OS Cross	1514.0	2242.0	2321.0	2814.0	2722.0	2973.0	3520.0	2586.57
Landini	1407.0	2009.0	2029.0	2448.0	2500.0	2711.0	2819.0	2274.71
Mean (T)	1460.50	2125.50	2175.00	2631.00	2611.00	2842.00	3169.50	--
LSD at 0.05 level	CVS = 42.49		T=35.18		CVS xT= 49.77			

The growth parameters of cabbage attributes were significantly influenced by fertilizer types and variety and the highest growth parameters (number of leaves and plant height) were obtained from plant received NPK (15-15-15) in F1 milor (Olaniyi and Ojetayo , 2011).The application of NPK (15-15-15) fertilizer significantly increased the cabbage growth parameters compared to control (Moyin-Jesu1,2015) .

Foliar spray with amino acid at 2 ml/l caused highly significant increases in stem diameter, whole stem weight, number of total leaves/ plant, weights of outer leaves (inedible), inner leaves (edible) and total leaves/ plant of

Chinese cabbage compared to the control (unsprayed) treatment in both seasons (El-Afifi *et al.* , 2014). Spraying with amino acids at2 ml/l increased plant height, stem lenth, number of leaves / plant, number of outer and inner leaves / plant, stem fresh weight and plant fresh weight of cabbage cv Balady compared to spraying with normal water (Mohamed and Zewail ,2016).

2. Head yield

Head yield/plant and total head yield / fad.

Data in Tables 6 and 7 show that there were significant differences between cabbage cultivars (OS Cross and Landini) in head yield / plant and total head yield

/fad. in both seasons, and OS Cross recorded higher yield / plant and total head yield /fad. Differences between cultivars could be due to genetic differences.

Foliar spray with amino acids at 1.5 or 3 ml/l and NPK (15-15-15) fertilizer at 1 or 2 ml /l increase yield / plant and total head yield /fad. compared to control (spraying with tap water) and spraying with amino acids at 3 ml/l and NPK (15-15-15) fertilizer at 2 ml /l gave the highest values of head yield / plant and total head yield /fad., followed by spraying with amino acids at 1.5 ml/l and NPK (15-15-15) fertilizer at 1 ml /l.

The interaction between OS Cross cultivar and spraying with amino acids at 3 ml/l and NPK (15-15-15) fertilizer at 2 ml /l gave the highest values of head yield / plant and total head yield /fad., followed by the interaction between OS Cross cultivar and spraying with amino acids at 1.5 ml/l and NPK (15-15-15) fertilizer at 1 ml /l. in both seasons. Total yield of cabbage (ton/fed) was highly significant positively correlated with either head weight (kg), head diameter (cm) or number of head leaves (El Sagan, 2014)

The yield of cabbage attributes were significantly influenced by fertilizer types and variety (Olaniyi and

Ojetayo ,2011) . The application of NPK (15-15-15) fertilizer significantly increased the cabbage head yield compared to control (Moyin-Jesu1,2015)

Amino acids are a well-known stimulant which has positive effects on plant growth, yield and significantly mitigates the injuries caused by abiotic stresses. Also, amino acids an essential quantity is well known as a means have positive effects on plant growth, yield and quality of different crops. Amino acids are fundamental ingredients in the process of protein synthesis; formation of plant tissue and chlorophyll synthesis (Kowalczyk and Zielony, 2008). Foliar spray with amino acid at 2 ml/l caused highly significant increases in fresh weights of total yield (whole head) and marketable yield (edible head) of Chinese cabbage compared to the control (unsprayed) treatment in both seasons). The increase (%) in weights of total and marketable yield resulted from foliar spray with amino acid over no spray were 43.3 and 14.8 (%) as av. two seasons (El-Afifi *et al.* ,2014). Spraying with amino acids at 2 ml/l increased head fresh weight of cabbage cv Balady compared to spraying with normal water (Mohamed and Zewail , 2016) .

Table 6. Effect of cultivars, foliar spray with amino acids and NPK rates and their interaction on head yield / plant (Head +stem weight) (g) of cabbage plant during 2017 / 2018 and 2018 / 2019 seasons

Cabbage cultivars (cvs)	Tap water	Amino acids and NPK (15:15:15) rates (T)						Mean (CVS)
		Amino acid (1.5 ml/l)	NPK (1ml/l)	Amino acid (3 ml/l)	NPK (2ml/l)	Amino acid (1.5 ml/l)+ NPK (1ml/l)	Amino acid (3 ml/l)+ NPK (2ml/l)	
2017 / 20 18 season								
OS Cross	2991.00	4014.00	4312.00	5373.00	5377.00	5580.00	6390.00	4862.43
Landini	2944.00	3587.00	3854.00	4783.00	4588.00	4757.00	5426.00	4277.00
Mean (T)	2967.50	3800.50	4083.00	5078.00	4982.50	5168.50	5908.00	--
LSD at 0.05 level	CVS = 50.17		T=28.58		CVS xT= 40.43			
2018 / 20 19 season								
OS Cross	2768.00	3885.00	4264.00	5120.00	5249.00	5659.00	6410.00	4765.00
Landini	2518.00	3433.00	3736.00	4441.00	4482.00	4945.00	5209.00	4109.14
Mean (T)	2643.00	3659.00	4000.00	4780.50	4865.50	5302.00	5809.50	--
LSD at 0.05 level	CVS = 32.15		T=24.85		CVS xT= 35.16			

Table 7. Effect of cultivars, amino acids and NPK rates and their interaction on total yield (ton/fad.) of cabbage plant during 2017 / 2018 and 2018 / 2019 seasons

Cabbage cultivars (cvs)	Tap water	Amino acids and NPK (15:15:15) rates (T)						Mean (CVS)
		Amino acid (1.5 ml/l)	NPK (1ml/l)	Amino acid (3 ml/l)	NPK (2ml/l)	Amino acid (1.5 ml/l)+ NPK (1ml/l)	Amino acid (3 ml/l)+ NPK (2ml/l)	
2017 / 20 18 season								
OS Cross	17.447	23.414	25.152	31.341	31.364	32.548	37.273	28.363
Landini	17.172	20.923	22.480	27.899	26.762	27.748	31.650	24.948
Mean (T)	17.309	22.168	23.816	29.620	29.063	30.148	34.461	0.000
LSD at 0.05 level	CVS = 0.292		T=0.166		CVS x T= 0.235			
2018 / 20 19 season								
OS Cross	16.146	22.661	24.872	29.865	30.617	33.009	37.390	27.794
Landini	14.687	20.025	21.792	25.904	26.144	28.844	30.384	23.969
Mean (T)	15.417	21.343	23.332	27.885	28.380	30.927	33.887	0.000
LSD at 0.05 level	CVS = 0.188		T=0.145		CVS xT= 0.205			

Relative total head yield

The increases in total head yield were about 13.68 and 15.95 % for OS Cross over the Landini cultivar in the 1st and 2nd seasons, respectively (Table 8) . The increases in total head yield /fad. were 99.09 and 119.80 % for spraying with amino acids at 3 ml/l + NPK (15-15-15) fertilizer at 2 ml /l, 74.18 and 100.60 % for spraying with amino acids at 1.5 ml/l + NPK (15-15-15) fertilizer at 1 ml /l over the

control in the 1st and 2nd seasons, respectively .The increases in total head yield /fad. were 117.06 and 154.58 % for the interaction between OS Cross cultivar and spraying with amino acids at 3 ml/l + NPK (15-15-15) fertilizer at 2 ml /l and 89.54 and 124.75 % for the interaction between OS Cross cultivar and spraying with amino acids at 1.5 ml/l + NPK (15-15-15) fertilizer at 1 ml /l over the interaction between Landini cultivar and spraying with tap water in the

1st and 2nd seasons, respectively. The increase (%) in weights of total and marketable yield of Chinese cabbage resulted from foliar spray with amino acid over no spray were 43.3 and 14.8 (%) as av. two seasons (ElAfifi et al. ,2014).

Table 8. Effect of cultivars, foliar spray with amino acids and NPK rates and their interaction on relative increases in total yield (%) of cabbage plant during 2017 / 2018 and 2018 / 2019 seasons

Cabbage cultivars (cvs)	Tap water	Amino acids and NPK (15:15:15) rates (T)						RYcv
		Amino acid (1.5 ml/l)	NPK (1ml/l)	Amino acid (3 ml/l)	NPK (2ml/l)	Amino acid (1.5 ml/l)+ NPK (1ml/l)	Amino acid (3 ml/l)+ NPK (2ml/l)	
2017 / 2018 season								
OS Cross	101.60	136.35	146.47	182.51	182.65	189.54	217.06	113.68
Landini	100.00	121.84	130.91	162.47	155.85	161.59	184.31	100.00
RYT	100.00	128.07	137.59	171.12	167.91	174.18	199.09	---
LSD at 0.05 level								
2018 / 2019 season								
OS Cross	109.93	154.29	169.35	203.34	208.46	224.75	254.58	115.95
Landini	100.00	136.35	148.38	176.37	178.01	196.39	206.88	100.00
RYT	100.00	138.44	151.34	180.87	184.08	200.60	219.80	---
LSD at 0.05 level								

Relative total yield %= Yield of treatment / yield of control x100, Control of cultivars : Landini , Control of Amino acids and NPK rates as foliar spray (T)= spraying with tap water, Control of the interaction = Landini x spraying with tap water, RYcvs= Relative yield of cultivar , RY T = Relative yield of T

3. Head quality

Data in Table 9 and 10 show that there were significant differences between OS Cross and Landini cultivars in head diameter and head circumferences in both seasons , OS Cross recorded higher head diameter and head circumference .

Spraying cabbage plants with amino acid at 1.5 and 3 ml/l + NPK (15-15-15) fertilizer at 1 and 2 ml /l single or in combinations increased head diameter and head circumferences compared to control (spraying with tap water) and spraying with amino acid at 3 ml/l + NPK (15-

15-15) fertilizer at 2 ml /l gave the highest values of head diameter and head circumferences.

The interaction between OS Cross cultivar and spraying with amino acid at 3 ml/l + NPK (15-15-15) fertilizer at 2 ml /l significantly increased head diameter and head circumferences, followed by the interaction between OS Cross cultivar and spraying with amino acid at 1.5 ml/l + NPK (15-15-15) fertilizer at 1 ml /l in both seasons. Mohamed and Zewail (2016) revealed that spraying with amino acids at 2 ml/l increased head diameter and circumference of cabbage cv Balady compared to control (spraying with normal water).

Table 9. Effect of cultivars, amino acids and NPK rates and their interaction on head diameter (cm) of cabbage plant during 2017 / 2018 and 2018 / 2019 seasons

Cabbage cultivars (cvs)	Tap water	Amino acids and NPK (15:15:15) rates (T)						Mean (CVS)
		Amino acid (1.5 ml/l)	NPK (1ml/l)	Amino acid (3 ml/l)	NPK (2ml/l)	Amino acid (1.5 ml/l)+ NPK (1ml/l)	Amino acid (3 ml/l)+ NPK (2ml/l)	
2017 / 2018 season								
OS Cross	24.0	27.0	26.0	28.0	29.0	30.0	33.0	28.14
Landini	15.0	19.0	28.0	25.0	26.0	28.0	30.0	24.43
Mean (T)	19.50	23.00	27.00	26.50	27.50	29.00	31.50	---
LSD at 0.05 level CVS = 1.16 T=1.03 CVS xT= 1.47								
2018 / 2019 season								
OS Cross	22.0	26.0	26.0	27.0	28.0	31.0	34.0	27.71
Landini	15.0	20.0	25.0	25.0	26.0	28.0	29.0	24.00
Mean (T)	18.50	23.00	25.50	26.00	27.00	29.50	31.50	---
LSD at 0.05 level CVS = 1.87 T=2.21 CVS xT= 3.14								

Table 10. Effect of cultivars, foliar spray with amino acids and NPK rates and their interaction on head circumferences (cm) of cabbage plant during 2017 / 2018 and 2018 / 2019 seasons

Cabbage cultivars (cvs)	Tap water	Amino acids and NPK (15:15:15) rates (T)						Mean (CVS)
		Amino acid (1.5 ml/l)	NPK (1ml/l)	Amino acid (3 ml/l)	NPK (2ml/l)	Amino acid (1.5 ml/l)+ NPK (1ml/l)	Amino acid (3 ml/l)+ NPK (2ml/l)	
2017 / 2018 season								
OS Cross	69.0	73.0	74.0	74.0	72.0	79.0	84.0	75.00
Landini	64.0	65.0	64.0	67.0	68.0	69.0	70.0	66.71
Mean (T)	66.50	69.00	69.00	70.50	70.00	74.00	77.00	---
LSD at 0.05 level CVS = 1.22 T=1.49 CVS xT= 2.11								
2018 / 2019 season								
OS Cross	62.0	71.0	73.0	74.0	72.0	77.0	80.0	72.71
Landini	54.0	65.0	66.0	68.0	68.0	72.0	74.0	66.71
Mean (T)	58.00	68.00	69.50	71.00	70.00	74.50	77.00	---
LSD at 0.05 level CVS= 2.79 T=2.71 CVSxT= 3.84								

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تأثير الرش الورقي بسماد النتروجين والفوسفور والبوتاسيوم والأحماض الأمينية على نمو وانتاجية صنفين من الكرنب النامي في الارض الرملية

سمر عبد الله برديسى¹ ، هاني جمال زيادة¹ ومنال عبد الحميد مندور²

¹ قسم البساتين- كلية الزراعة - جامعة الزقازيق - مصر

² المعمل المركزي للزراعة العضوية - مركز البحوث الزراعيه

أجرى هذا العمل بمزرعة خاصة (مزرعة التجارب التابعه لشركة ساند فالي) بالإسماعلية - محافظة الإسماعلية - مصر خلال موسمي 2018/2017، 2019/2018 بهدف دراسة تأثير الرش بالسماد الورقي النيتروجين والفوسفور والبوتاسيوم (15-15-15) بمعدل 1، 2 مل / لتر والأحماض الأمينية بمعدل 1.5، 3 مل / لتر على صنفين من الكرنب (أوه إس كروس ولاندينا) الناميه تحت ظروف الارض الرملية . سجلت معاملته التفاعل بين رش صنف الكرنب أوه إس كروس بالأحماض الأمينية بمعدل 3 مل / لتر و السماد الورقي النيتروجين والفوسفور والبوتاسيوم (15-15-15) بمعدل 2 مل / لتر الى زياده الوزن الطازج للجذور والساق ، عدد الأوراق / الراس والوزن الطازج للأوراق الخارجية والداخلية /الراس ، محصول الرأس / النبات ، ومحصول الرؤوس للقدان وكذلك قطر ومحيط الراس ، يليه رش صنف الكرنب أوه إس كروس بالأحماض الأمينية بمعدل 1.5 مل / لتر و السماد الورقي النيتروجين والفوسفور والبوتاسيوم (15-15-15) بمعدل 1 مل / لتر بدون فروق معنويه بين التفاعل بين رش الصنف لاندينا والرش بالأحماض الأمينية بمعدل 1.5 مل / لتر و السماد الورقي النيتروجين والفوسفور والبوتاسيوم (15-15-15) بمعدل 1 مل / لتر بخصوص عدد الأوراق على الرأس.