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Flowers Production and Chemical Constituents of *Helichrysum bracteatum* Andr. as Influenced by Plant Spacing and NK Fertilization

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Abstract: The annual flowering plants are very important in the garden landscaping in Egypt as other regions. Two field experiments were carried out at the Agricultural Experiment and Research Station, Faculty of Agriculture, Cairo University, Giza during 2006-2007 and 2007-2008 seasons to study the effect of plant spacing, nitrogen and potassium fertilization on the flower production and chemical composition of strawflower plant (*Helichrysum bracteatum* Andr.). Plant spacing treatments were 20, 30 and 40cm. Fertilization treatments were ammonium nitrate (33.5% N) at the rates of 100,150 and 200Kg/fed (N1, N2 and N3, respectively) and potassium sulphate (48% K_2O) at the rates of 50 and 75Kg/fed (K1 and K2, respectively), in addition to control treatment. The results indicated that the highest values of number of spray/plant, number of inflorescences/spray, number of inflorescences/plant, inflorescence diameter, fresh and dry weights of spray, total carbohydrates percentages in inflorescences, nitrogen, phosphorus, potassium content in inflorescences were obtained for planting distance of 40 cm. The application of N3K2 treatment increased inflorescences characters, total carbohydrates percentages, nitrogen and potassium content in inflorescences as compared with control plant. Interaction between plant spacing and NK resulted in the maximum values for number of inflorescences/plant, inflorescence diameter, fresh and dry weight of spray, nitrogen and potassium in inflorescences cultivated at 40cm apart with application of 200kg ammonium nitrate and 75kg potassium sulphate.
Keywords: Annual Plants, Strawflower, Plant Spacing, Nitrogen, Potassium, Fertilizer.

Introduction

Home owners use annuals in their gardens as beddings plants, borders and focal points for color and beauty. Annual plants are also widely used in public parks, on medium and roadside planting. Strawflower is considered hardy annual or everlasting (*Helichrysumbracteatum*Andr.).Family Asteraceae is an easy annual plant to grow given different colored flower heads. It is endemic to Australia, growing in open scrub and grassland areas. The true petals are found in the center of each flower and they are surrounded by colorful, straw like bracts. The flowers bloom late in winter to summer. The flowers are harvested for drying before fully opening and used in dried arrangements, they open fully. Proper nutrition of these plants is important to

produce abundant flowers of adequate size and color intensity with good lasting qualities. Nitrogen (N) plays a pivotal role in many critical functions (such as photosynthesis) as well major component of amino acids, which affect forming protoplasm, the site of cell division and plant growth. It is necessary for enzymatic reactions in plants, since all plant enzymes are proteins. Moreover, it is a necessary component of several vitamins, *e.g*., biotin, thiamine, niacin and riboflavin and the nucleic acids (DNA and RNA).Potassium (or Potash) plays roles in regulating the opening and closing of stomata and water retention. It promotes the growth of meristematic tissues activating some enzymatic reactions, aids in nitrogen metabolism, and the synthesis of proteins, catalyzes activities of some mineral elements, and aids in carbohydrate metabolism and translocations[1]. Vegetative growth and flowering are affected with plant spacing, nitrogen and potassium fertilizers. [2] showed that the branches number and dry weight of *Helianthus annuus* L. plant were increased with NP combined with K. [3]found that the head diameter increased with the lowest plant population of *Helianthus annuus* L.[4] found that the N rate 200 Kg/ha resulted in the greatest flower diameter, number and weight of flowers per plant in China aster. [5]concluded that the highest flower diameter was achieved with the application of all nitrogen levels and 50 ppm K,while the highest number of flowers was produced by marigold at 100 ppm K , for all nitrogen levels.

The objective of the present study was to find out the effect of plant spacing and NK fertilization treatments on the flowering and chemical composition of strawflower.

Materials and Methods

Two field experiments were carried out at the Agricultural Experiment and Research Station, Faculty of Agriculture, Cairo University, during 2006-2007 and 2007-2008 seasons to study the effect of plant spacing and NK fertilization on growth and flowering of *Helichrysum bracteatum*Andr. Seedlings were obtained from the Department of Ornamental Plants and Woody Trees, National Research Centre, Giza, Egypt. In the first week of November in both seasons, uniformed seedlings (18-20cm height) of *Helichrysum bracteatum* were transplanted using 2 seedlings/hill, and thinned for one plant/hill after 30 days from transplanting. The layout of the experiment was split plot design, including twenty one treatments, which were the combinations between three plant spacing and seven fertilization treatments. Three replicates were carried out for each treatment giving 63 plots. Plant spacing was designed as the main plot with three distances between plants along the row 20, 30 and 40 cm apart. NK fertilization treatments were the sub-plots and were in combination between ammonium nitrate (33.5%N) at the rates of 100,150 and 200Kg/fed (N1, N2, N3, respectively) and potassium sulphate(48%K_2O)at the rates of 50 and 75Kg/fed (K1 and K2, respectively). The fertilization treatments were as follows: N1K1, N2K1, N3K1, N1K2, N2K2 and N3K2 in addition to the control. Ammonium nitrate and potassium sulphate were added in two equal doses. The first dose was added after 45 days from transplanting, whereas the second part was added three weeks later. Calcium superphosphate (15.5%P_2O_5) at the rate of 100Kg/fed was applied before planting. Plot area was 5.25 m^2 (2.1 m in width and 2.5 m in length) containing three rows; the distance between rows was 70 cm. The plants received normal agricultural practices whenever needed. The following data were recorded at the 3rd week of April 2006 and 2008: Number of sprays/plant, number of inflorescences/ spray,number of inflorescences/plant, inflorescence diameter (cm) and fresh and dry weight of spray (g). Chlorophyll a, b and total carotenoids were determined in leaf samples (mg/g F.W.) according to [6]. Total carbohydrates content was determined according to[7]. Nitrogen contents were determined by the modified Kjeldahl method as described by [8]. Phosphorus content was estimated according to[9]. Potassium content was measured according to by [10].

The data collected were analyzed statistically using the combined analysis of variance by LSD test according to method of [11].

Results and Discussion

1-Flower characters:

The data on flower characters as affected by plant spacing and fertilization are shown in Table (1) and Fig. (1).these results may be discussed as follows:

Plant spacing of 40 cm between plants increased number of sprays/plant, inflorescences/spray, inflorescences/plant, inflorescence diameter and fresh &dry weight of spray. The differences between the plants

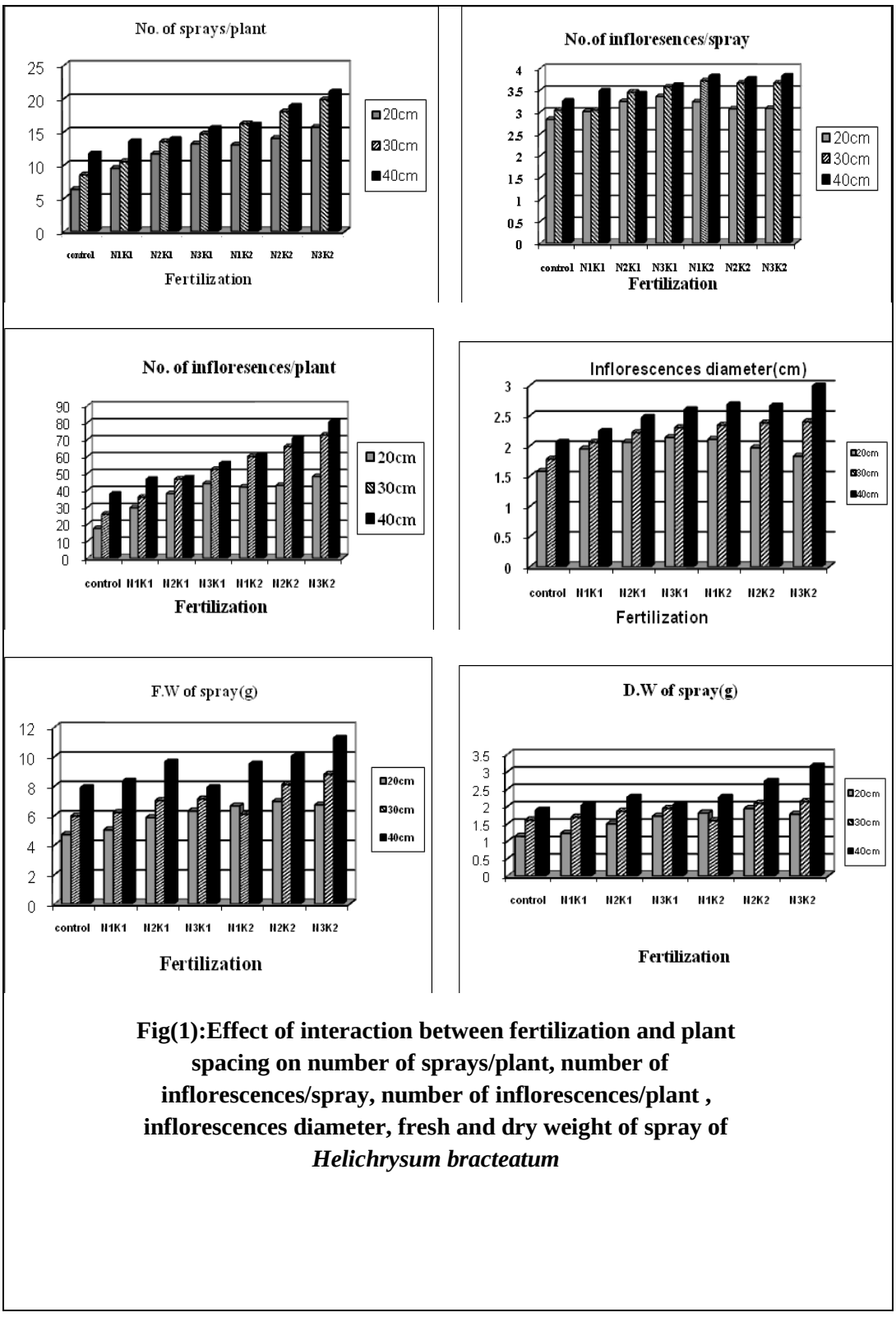
spacing affected slightly on number of inflorescences/spray. The differences between all plant spacing treatments affected significantly on number of inflorescences/plant and inflorescences diameter. High flower production under the low plant density may be due to larger space thus more water and nutrients which gave more laterals that grew into flowering. Similar results were reported by [12]on Celery, [13] on anise; [14] on China aster; [15]on *Borago officinalis* and [3]on sunflower. They indicated that the wider space increased the flower characters compared to the closer space.

Table (1): Effect of plant spacing and fertilization on number of sprays/plant, number of inflorescences/spray, number of inflorescences/plant, inflorescences diameter, fresh and dry weight of *Helichrysum bracteatum* plants.

D.W of spray(g)	F.W of spray(g)	Inflorescences diameter(cm)	No. of inflorescences /plant	No. of inflorescences /spray	No. of sprays /plant	Treatments
Effect of plant spacing						
1.59	6.02	1.94	37.52	3.11	11.90	20cm
1.84	7.03	2.21	51.37	3.45	14.45	30cm
2.34	9.21	2.53	57.07	3.59	15.76	40cm
0.08	0.14	2.02	1.40	0.04	0.41	LSD at0.05
Effect of fertilization						
1.55	6.18	1.81	27.07	3.04	8.83	control
1.65	6.52	2.08	37.44	3.18	11.16	N1K1
1.87	7.49	2.21	44.07	3.37	13.00	N2K1
1.90	7.10	2.34	50.75	3.51	14.44	N3K1
1.89	7.40	2.38	54.30	3.58	15.06	N1K2
2.25	8.35	2.33	59.86	3.49	16.94	N2K2
2.36	8.91	2.41	67.06	3.57	18.83	N3K2
0.12	0.23	0.03	3.30	0.08	0.94	LSD at0.05

The highest number of sprays/plant, inflorescences/plant, inflorescences diameter, fresh and dry weight of spray were obtained by using high level of ammonium nitrate and potassium sulphate, i.e. (200 kg ammonium nitrate /fed +75 kg potassium sulphate/fed), while the highest number of inflorescences/spray had been obtained with application 100 kg ammonium nitrate /fed +75 kg potassium sulphate/fed. All NK fertilizer treatments increased number of sprays/plant and number of inflorescences/spray as compared to the control. The highest level of potassium (K2) was the most effective on increasing the inflorescence diameter. Raising K rate in NK treatments with the three levels of N gave a gradual increase in fresh and dry weights of spray. The role of potassium in an increasing flower production and quality would return to its function in plants which include cat ion transport across membranes, energy metabolism and enzyme activation on exchange rate and nitrogen activity as well as enhanced carbohydrate movement from shoot to storage organs. These findings are in agreement with those obtained by [13] on anise; [16]on *Carumcarv*;[4] on China aster L.;[17] on *Calendula officinalis* and [5]on marigold found that both the levels of nitrogen and potassium improved flower characters.

The highest value of all flower characters (number of spray/plant, number of inflorescences/spray, number of inflorescences/plant, inflorescences diameter and fresh &dry weight of spray) resulted from application of high rates of fertilization (200 kg ammonium nitrate /fed +75 kg potassium sulphate/fed) at 40cm between plants. Raising the level of potassium from K1 to K2 at the same level of nitrogen resulted in significant increase in number of sprays/plant under any plant spacing. There were no significant differences on the number of inflorescences/ sprays between the levels of nitrogen with the high level of potassium (K2) either plant spacing at 30 or 40 cm apart. All combinations between plant spacing and NK fertilization treatments increased the number of inflorescences/plant compared to any plant spacing with control.



Fig(1):Effect of interaction between fertilization and plant spacing on number of sprays/plant, number of inflorescences/spray, number of inflorescences/plant , inflorescences diameter, fresh and dry weight of spray of *Helichrysum bracteatum*

2-Chemical composition

a. Total carbohydrates percentage

Data obtained on the total carbohydrates content of inflorescence as affected by plant spacing and NK fertilizer are presented in Table (2). The results can be discussed as follows:

Table (2):- Effect of plant spacing and fertilization on nitrogen, phosphorus, potassium and carbohydrates % in inflorescences of *Helichrysum bracteatum* (Average of two seasons).

Fertilization	Plant spacing (cm)							
	20	30	40	Mean	20	30	40	Mean
	Carbohydrates % inflorescences				N% inflorescences			
Control	21.92	11.96	16.81	16.90	1.83	1.97	2.27	2.02
N1K1	25.90	18.40	19.78	21.36	2.07	2.20	2.61	2.30
N2K1	28.14	19.38	22.74	23.42	2.18	2.36	2.69	2.41
N3K1	26.06	21.64	17.65	21.78	2.28	2.53	2.90	2.57
N1K2	22.82	18.97	26.34	22.71	2.10	2.32	2.58	2.33
N2K2	27.94	28.53	27.71	28.05	2.31	2.53	2.77	2.53
N3K2	29.84	31.61	29.61	30.35	2.37	2.61	3.03	2.68
Mean	26.09	21.50	22.95		2.17	2.36	2.69	
	P% inflorescences				K% inflorescences			
Control	0.23	0.25	0.26	0.25	0.97	1.15	1.34	1.15
N1K1	0.26	0.29	0.31	0.29	1.29	1.54	1.65	1.50
N2K1	0.29	0.24	0.30	0.28	1.28	1.50	1.65	1.48
N3K1	0.29	0.28	0.24	0.27	1.31	1.67	1.78	1.59
N1K2	0.21	0.28	0.29	0.26	1.42	1.76	1.85	1.67
N2K2	0.19	0.28	0.31	0.26	1.33	1.86	2.01	1.73
N3K2	0.26	0.31	0.33	0.30	1.40	1.92	2.14	1.82
Mean	0.24	0.27	0.29		1.28	1.63	1.78	

Significant effect of spacing had been obtained in the inflorescences. In the first spray, the highest total carbohydrates percentage was obtained from plants at 40 cm apart spacing, while the closer spacing (20 cm) gave the least values. On the other hand; it was found that in the final spray, the wider spacing 40 cm apart resulted in least value for total carbohydrates, while highest total carbohydrates were obtained from plants spaced at 20cm apart.

All applied rates of NK fertilizer resulted in significant increase in total carbohydrates percentage of the inflorescences as compared to the control. The highest percentages of total carbohydrates in the inflorescences were detected in the flowers of the plants supplied with NK fertilizer at the rate of 3:2. Using the high level of potassium (K2) at the three levels of nitrogen increased gradually total carbohydrates percentages in inflorescences. Generally, higher levels of potassium (K2) at the different levels of nitrogen were more effective on increasing total carbohydrates for the inflorescences as compared with the low level of potassium (K1).

The highest percentage of total carbohydrates in the final spray (37.4) had been obtained from treating the plants with NK at the rate of 3: 2 combined with the distance of 30 cm. Untreated plants combined with plant spacing at 30cm apart contained the lowest total carbohydrates content.

b. Minerals concentration (N, P &K %)

Data on nitrogen (N),phosphorus (P) and potassium (K) percentages of inflorescences in response to plant spacing and NK fertilizer treatments are presented in Table(2).

Plant spacing had a remarkable effect on N, P & K% in inflorescences which increased with increasing the space between plants. The distance of 40 cm between plants caused the accumulation of the highest amount of nitrogen in inflorescences. The closer distance (20 cm) between plants contained the least N, P & K% in inflorescences. Similar results were reported by[18] on caraway; [19]on chamomile. [20]on fennel and [21] on *Helianthus annuus*L., they found that nitrogen, phosphorus and potassium percentages were increased by increasing the spacing between plants.

All NK fertilizer treatments increased nitrogen, phosphorus and potassium content in inflorescences compared with the untreated plants. NK treatment at 3:2 was the most effective treatment for giving the highest

N, P & K% in inflorescences. Applying NK at 1:2 caused the accumulation of the least amount of nitrogen in inflorescences, but higher than the control. These findings were in agreement with the results obtained by [2] found that contents of N, P and K in leaves increased with N:P at 60:60 kg/fed combined with K at 72 or 96 kg/fed of *Helianthus tuberoseus* and [22] found that fertilizing *Salvia officinalis* plants with 150 kg ammonium sulphate, 150 kg calcium superphosphate and 100 kg potassium sulphate/fed caused a significant increase in N,P and K contents.

The highest N, P & K% in inflorescences resulted from a combination of the wider space 40cm apart with NK fertilizer at the rate of 3:2. In contrast, the lowest nitrogen concentration in inflorescences was recorded when the closer space 20cm apart was combined with NK fertilizer at 1:2. Using of the three levels of nitrogen at the highest level of potassium (K2) resulted in gradual increase in nitrogen content of the inflorescences under any plant spacing. These findings were in agreement with that of [23] on *Pimpinella anisum* and [24] on *Nigella sativa.*

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