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Standardization of spacing and fertilizer for high yield, quality and nutrient status in bachelor's button CV.AGS-5

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Abstract
This study was carried out to investigate the standardization of spacing and fertilizer on growth and quality of Bachelor's button cv.AGS-5. The treatments consisted of six fertilizer levels (F_1:150:75:75 NPK kg per ha, F_2:150:75:150 NPK kg per ha,F_3:200:75:75 NPK kg per ha, F_4:200:75:150 NPK kg per ha, F_5:250:75:75 NPK kg per ha, F_6:250:75:150 NPK kg per ha), two spacing levels (S_1: 45 cm x 30 cm and S_2: 60 cm x 30 cm) tested in factorial randomized block design with three replications. The vegetative parameter *viz.*, plant height increased with decrease in spacing level and increase in nutrition. The interaction of S_1F_6 (45 x 30 cm: 250:75:150 NPK kg/ ha) recorded higher plant height. Plant spread, number of branches, stem girth, number of leaves. Flower production was significantly influenced by spacing at 45 x 30 cm, and nutrition at 250:75:150 NPK kg/ ha. The treatment combination of S_1F_6 (45 x 30 cm: 250:75:150 kg/ ha) produced more flower yield per ha (18.20 t/ha). It is on par with S_1F_5 i.e 17.64 t/ha. Increasing levels of spacing and nutrition increased the duration of flowering, flower diameter, flower weight, shelf life of flower on plant and seed yield significantly. Duration of flowering, flower diameter, flower weight, shelf life of flower on plant and seed yield proved superior with 60 x 30cm spacing and nutrition at 250:75:150 NPK kg/ ha.

Keywords: Spacing, fertilizer, yield, quality, nutrient status bachelors button

Introduction
Bachelor's button (*Gomphrena globosa*) belongs to the family Amaranthaceae. It is also known as Globe amaranth. It is native to India. It is an annual flower crop that grows up to 45 to 60 cm tall with linear and alternate leaves. The flower heads are about one and half cm across and are available in blue, purple, white, rose or red colours. It is a drought tolerant annual. The leaves are covered with small white hairs resulting in blue-gray appearance. The upper half of the plant is multi-stemmed and producing many flowers. Bachelor's button is a leading commercial dry flower crop with immense export potential. It occupies seventh position in the world dry flower market (Anon, 1989) [3]. In India, it is grown in some parts of Karnataka, Tamil Nadu, Kerala and Andhra Pradesh. In Karnataka, it is grown in Dharwad, Raichur, Bellary and Bangaluru districts. Nutrition is one of the most important aspects in increasing the flower yield. A suitable fertilizer dose and planting density will certainly help in deciding the yield and quality of flowers. The present investigation was, therefore undertaken in order to determine the most suitable spacing and fertilizer dose in Bachelor's button cv. AGS-5.

Material and Methods
The experiment was carried out on bachelor's button (*Gomphrena globosa*) cv.AGS-5 in factorial randomized block design with three replications during the year of 2015 under field condition at department of Floriculture and Landscape Architect, K.R.C. College of Horticulture, Arabhavi. The treatments consisted of six fertilizer levels (F_1:150:75:75 NPK kg per ha, F_2:150:75:150 NPK kg per ha,F_3:200:75:75 NPK kg per ha, F_4:200:75:150 NPK kg per ha, F_5:250:75:75 NPK kg per ha, F_6:250:75:150 NPK kg per ha), two spacing levels (S_1: 45 cm x 30 cm and S_2: 60 cm x 30 cm), seeds are sown in pro- trays one month after sowing the seedlings are transplanted to main field with a two spacing levels (S_1: 45 cm x 30 cm and S_2: 60 cm x 30 cm) as per the treatment. The experimental plots were incorporated with well decomposed FYM, Half dose of N and full dose of P and K was applied as a basal dose and remaining half dose applied at 30 days after transplanting.

All cultural operations were carried out uniformly. Nitrogen content in leaf was estimated by Modified Kjeldahls procedure, phosphors by calorimetric method and potash with the help of flame photometer as described by Jackson (1967) [10]. Available nitrogen in the soil was determined by alkaline permanganate method as outlined by Subbiah and Asija (1956) [19], available phosphorus was estimated by colorimetric method as outlined by Olsen *et al*. (1954) [15] and available potassium was extracted with neutral normal ammonium acetate and the quantity was determined by using flame photometer as suggested by Stanford and English (1963) [21] expressed in kg per hectare. The data was recorded on different growth and yield parameters from five tagged plants and average was statistically analyzed.

Result and Discussion

Growth parameter

The treatment differences due to different levels spacing and fertilizer application were significant for plant height, number of branches, and plant spread (Table 1).

At 90 DAT except plant height, number of branches, and plant spread at both direction N-S and E-W was recorded maximum in (S_2) 60 x 30 cm spacing (18.36, 47.56 cm and 47.24 cm)which was significantly higher than S_1 (17.26, 45.05 cm and 45.59 cm).plant height was recorded maximum in S_1(61.91). In case Fertilizer doses At 90 DAT plant height (70.12 cm), number of branches (23.06), and plant spread at both direction N-S (54.13 cm) and E-W (53.78) was recorded maximum F_6.and it was minimum inF_1.

In case of interaction the wider spacing with higher fertilizer dose (S_2F_6) shows maximum plant height (68.03 cm), number of branches (25.00), and plant spread at both direction N-S (58.60 cm) and E-W (57.83 cm).

Treatment combination S_1F_6 (60 cm x 30 cm and 250:75:150 NPK kg per hectare) influenced in producing longest statured plants. While the treatment combination S_2F_1 which was found on par with certain other treatments at all stages the crop growth recoded minimum plant height. The *Gomphrena* plants in the S_1F_6 treatment, picked-up the effect in the early stages of the period of the crop growth. This effect continued till the end of the period of the crop growth. In contrast, the plants in the treatment S_2F_1 picked-up the effect at later stages resulting in shortest statured *Gomphrena* plants and found on par with other treatments.

Whereas, with regard to branches per plant, spread of plant, the treatment combination S_2F_6 (60 cm x 30 cm and 250:75:15 NPK kg per hectare) produced the maximum effect, while minimum effect was seen in treatment S_1F_1 and it was found on par with other treatments at different stages of the period of the crop growth.

This gave an indication that closer spacing of 45 cm x 30 cm coupled with higher nutrition resulted in producing longest statured *Gomphrena* plants, while wider spacing 60 cm x 30 cm coupled with higher nutrition influenced all other growth parameters except plant height.

Yield parameter

The data regarding flower and seed yield was affected by spacing, fertilizer and their interactions is presented in Table 2.

Spacing exhibited significant variation in flower and seed yield per plant. Maximum flower and seed yield per plant (189.29 g and 64.25 g) was recorded in 60 x 30 cm spacing (S_2) and minimum (169.29g and 52.55 g) was recorded in S_1(45 x 30 cm).but in case of per ha it was maximum in S_1 (45 x 30 cm) 15.12 t and 3.39 t/ha.

Higher fertilizer dose F6 recorded maximum seed and flower yield per plant and per ha. In case of interaction the wider spacing with higher fertilizer dose (S_2F_6) shows maximum flower and seed yield per plant. And yield per ha was maximum in S_1F_6.

It is mainly due to more number of plants accommodated in the treatments comprising 45 cm x 30 cm spacing and high level of nutrition must have influenced in producing maximum weight and number of flowers per square metre, per plot and per hectare. Linkage of effect was evident from the results so obtained. Similar effects on yield with interaction was found by Venugopal (1991) [22] in everlasting flower, John and Paul (1992) [11] in globe amarnath, and Sodha and Dhaduk (2002) [20] in S*olidago*, Mishra (1998) [9] in gaillardia, Karavadia and Dhaduk (2002) [12] in chrydanthemum, Karuppaiah and Krishna (2005) [13] in French marigold and Sharma *et al*. 2009) [11] in African marigold.

Quality parameters

Significant effect of interaction was seen on the quality parameter like shelf life diameter of flower and stalk length fresh and dry weight of flower (Table3).

All the quality traits recorded highest in wider spacing of 60 cm x 30 cm coupled with higher level of nutrition. It is mainly due to availability more nutrients and less competition between the plant for nutrients resulted in increase in size and weight of flower. Similar effects on yield with interaction was found by Mishra (1998) [9] in gaillardia, Karavadia and Dhaduk (2002) [12] in chrydanthemum, Karuppaiah and Krishna (2005) [13] in French marigold and Sharma *et al*. (2009) [11] in African marigold.

Available nutrient in soil after harvest

The significant difference in nitrogen, phosphorus and potassium content was noticed. Nutrients supplied with F_6:250:75:150 NPK kg/ha recorded significantly higher available nitrogen, phosphorus and potassium (141.42, 9.79, and 151.67 kg/ha) respectively, and the lowest available nitrogen, phosphorus and potassium in soil (108.22, 7.23 and 117.13 kg/ha) respectively, was observed in the treatment F_1 (150:75:75 kg NPK/ha) after harvest. This might be due to the higher available nitrogen present in the soil and also due to external application of nitrogenous and potassium fertilizers and their preferential absorption. The linear increase in nitrogen, phosphorus and potassium content upto F6 might be also due to the synergetic effect of phosphorus and potassium. Similar results were obtained by Airadevi, 2012 [1] in annual chrysanthemum.

Nutrient content in plant

The significant difference in nitrogen, phosphorus and potassium content was noticed. Among the different nitrogen and potassium levels application of F_6: 250:75:150 NPK kg / ha recorded higher nitrogen and potassium content respectively, (3.62% and 2.18%). and the lowest nitrogen and potassium content of 2.25 and 1.69 per cent was observed in (F_1). This might be due to the higher available nitrogen in the soil due to external application of nitrogenous and potassium fertilizers and their preferential absorption, which helps in

higher uptake of macronutrients. The linear increase in nitrogen and potassium content upto F6 might be also due to the synergetic effect of phosphorus and potassium. Similar results were obtained by Airadevi, 2012 [1] in annual chrysanthemum.

Application of F_6: 250:75:150 NPK kg / ha recorded higher phosphorus content (0.37%) in plant and the lowest phosphorus content (0.24%) was observed in (F_1). It might be due to application of increased levels of nitrogen has increased phosphorus content of plant. Application of nitrogen increases the vegetative growth which in turn leads to better foraging capacity of other nutrients in order to maintain nutrient balance in the plant cell. Similar results were obtained by Airadevi, 2012 [1] in annual chrysanthemum.

Table 1: Growth parameters as influenced by different levels of spacing, fertilizer and their interaction in *Gomphrena globosa* cv.AGS-5

Treatment	Plant height(cm) 90 DAT	Number of branches per plant 90 DAT	Plant spread per plant (cm) N-S 90 DAT	Plant spread per plant(cm) E-W 90 DAT
Spacing level (S)				
S_1: 45 cm x 30 cm	61.91	17.26	45.05	45.59
S_2: 60 cm x 30 cm	58.87	18.36	47.56	47.24
S.Em.±	0.33	0.23	0.57	0.58
C.D. @ 5%	0.98	0.68	1.68	1.71
Fertilizer (F)				
F_1: 150:75:75NPK kg/ ha	53.82	14.80	42.25	42.78
F_2: 150:75:150 NPKkg/ ha	55.69	16.33	44.48	44.85
F_3: 200:75:75NPK kg / ha	61.31	17.54	45.95	45.78
F_4: 200:75:150 NPK kg/ ha	63.73	19.42	47.12	47.28
F_5: 250:75:75NPKkg/ ha	67.40	20.96	51.73	51.37
F_6: 250:75:150 NPK kg / ha	70.12	23.06	54.13	53.78
S.Em.±	0.58	0.40	0.99	1.01
C.D. @ 5%	1.70	1.19	2.91	2.97
Interaction (SXF)				
S_1F_1	54.34	13.77	41.93	42.93
S_1F_2	57.02	15.97	43.47	44.63
S_1F_3	63.77	17.54	45.07	45.10
S_1F_4	66.47	18.48	46.20	46.63
S_1F_5	67.93	20.57	48.60	48.64
S_1F_6	72.20	21.12	49.67	49.73
S_2F_1	53.29	15.83	42.57	42.63
S_2F_2	54.37	16.69	45.50	45.07
S_2F_3	58.85	17.54	46.84	46.47
S_2F_4	61.00	20.37	48.04	47.93
S_2F_5	66.86	21.36	54.87	54.10
S_2F_6	68.03	25.00	58.60	57.83
S.Em.±	0.82	0.57	1.40	1.43
C.D. @ 5%	2.41	1.68	4.12	4.20

DAT: Days after transplanting

Table 2: Flower and seed yield as influenced by different levels of spacing, fertilizer and their interaction in *Gomphrena globosa* cv.AGS-5

Treatment	Flower yield per plant (g)	Flower yield per hectare(t)	Seed yield (g/plant)	Seed yield(t/ha)
Spacing level (S)				
S_1: 45 cm x 30 cm	169.29	15.12	52.55	3.39
S_2: 60 cm x 30 cm	189.29	13.20	64.25	3.23
S.Em.±	2.56	0.18	0.74	0.06
C.D. @ 5%	7.52	0.53	2.19	0.18
Fertilizer (F)				
F_1: 150:75:75NPK kg/ ha	151.35	12.34	49.35	2.58
F_2: 150:75:150 NPKkg/ ha	160.47	13.41	52.77	2.78
F_3: 200:75:75NPK kg / ha	174.58	14.35	58.64	3.22
F_4: 200:75:150 NPK kg/ ha	188.68	14.63	61.39	3.60
F_5: 250:75:75NPKkg/ ha	221.37	16.07	69.87	4.35
F_6: 250:75:150 NPK kg / ha	237.82	16.68	73.30	4.80
S.Em.±	4.44	0.31	1.29	0.11
C.D. @ 5%	13.02	0.92	3.80	0.32
Interaction (SXF)				
S_1F_1	150.63	12.71	42.63	2.90
S_1F_2	152.80	13.85	44.83	2.77
S_1F_3	164.90	15.53	52.64	3.13
S_1F_4	174.00	15.87	55.73	3.50
S_1F_5	204.10	17.64	66.93	4.63
S_1F_6	216.87	18.20	70.80	5.13
S_2F_1	152.07	11.97	56.07	2.27

S_2F_2	168.13	12.97	60.70	2.80
S_2F_3	184.27	13.17	64.63	3.30
S_2F_4	203.37	13.40	67.05	3.70
S_2F_5	238.63	14.50	72.80	4.07
S_2F_6	258.77	15.17	75.80	4.47
S.Em.±	6.28	0.44	1.83	0.15
C.D. @ 5%	18.43	1.30	5.37	0.46

Table 3: Quality parameters as influenced by different levels of spacing, fertilizer and their interaction in *Gomphrena globosa* cv.AGS-5

Treatment	Flower diameter (cm)	Stalk length (cm)	Fresh weight of individual flower (g)	Dry weight of individual flower(g)	Shelf life (days)
Spacing level (S)					
S_1: 45 cm x 30 cm	1.34	19.61	0.35	0.19	3.62
S_2: 60 cm x 30 cm	1.38	22.34	0.44	0.23	4.21
S.Em.±	0.02	0.24	0.01	0.006	0.04
C.D. @ 5%	0.06	0.73	0.03	0.01	0.12
Fertilizer (F)					
F_1: 150:75:75NPK kg/ ha	1.18	16.64	0.25	0.13	3.30
F_2: 150:75:150 NPKkg/ ha	1.29	17.73	0.31	0.15	3.62
F_3: 200:75:75NPK kg / ha	1.38	21.52	0.40	0.21	3.98
F_4: 200:75:150 NPK kg/ ha	1.43	23.07	0.46	0.24	4.22
F_5: 250:75:75NPKkg/ ha	1.52	25.93	0.56	0.31	4.45
F_6: 250:75:150 NPK kg / ha	1.67	28.08	0.63	0.37	4.58
S.Em.±	0.03	0.43	0.01	0.01	0.07
C.D. @ 5%	0.11	1.26	0.05	0.03	0.22
Interaction (SXF)					
S_1F_1	1.18	15.85	0.25	0.13	3.27
S_1F_2	1.31	16.88	0.28	0.16	3.30
S_1F_3	1.35	19.63	0.33	0.17	3.73
S_1F_4	1.38	20.87	0.40	0.21	3.83
S_1F_5	1.50	24.83	0.46	0.28	3.97
S_1F_6	1.55	25.70	0.50	0.32	4.17
S_2F_1	1.19	17.43	0.24	0.14	3.33
S_2F_2	1.26	18.57	0.34	0.15	3.93
S_2F_3	1.41	23.40	0.47	0.24	4.23
S_2F_4	1.47	25.27	0.52	0.26	4.60
S_2F_5	1.54	27.03	0.65	0.35	4.93
S_2F_6	1.80	30.47	0.75	0.41	5.00
S.Em.±	0.05	0.61	0.02	0.015	0.10
C.D. @ 5%	0.16	1.79	0.07	0.04	0.31

Table 4: Available nutrient status of soil and Nutrient content (%) in leaf sample as influenced by different levels of spacing, fertilizer and their interaction in *Gomphrena globosa* cv.AGS-5

Treatment	Available nutrient status (kg/ha)			Nutrient content (%)		
	Nitrogen	Phosphorus	Potassium	Nitrogen	Phosphorus	Potassium
Spacing level (S)						
S_1: 45 cm x 30 cm	117.57	8.07	126.12	2.58	0.28	1.85
S_2: 60 cm x 30 cm	129.00	8.12	138.60	3.17	0.32	1.95
S.Em.±	0.58	0.07	0.56	0.033	0.002	0.005
C.D. @ 5%	1.71	0.22	1.66	0.097	0.006	0.015
Fertilizer (F)						
F_1: 150:75:75NPK kg/ ha	108.22	7.23	117.13	2.25	0.24	1.69
F_2: 150:75:150 NPKkg/ ha	113.37	7.59	121.67	2.62	0.27	1.83
F_3: 200:75:75NPK kg / ha	126.95	8.15	135.67	2.95	0.31	1.92
F_4: 200:75:150 NPK kg/ ha	129.17	8.53	138.17	3.15	0.34	1.99
F_5: 250:75:75NPKkg/ ha	138.73	8.97	149.17	3.40	0.35	2.07
F_6: 250:75:150 NPK kg / ha	141.42	9.79	151.67	3.62	0.37	2.18
S.Em.±	1.01	0.13	0.98	0.057	0.003	0.009
C.D. @ 5%	2.97	0.39	2.88	0.169	0.011	0.027
Interaction (SXF)						
S_1F_1	103.10	7.17	111.60	2.17	0.22	1.64
S_1F_2	106.73	7.55	114.33	2.30	0.25	1.76
S_1F_3	120.23	8.17	128.33	2.67	0.29	1.86
S_1F_4	122.67	8.60	131.00	2.80	0.33	1.95
S_1F_5	135.13	8.89	145.33	2.97	0.34	2.03
S_1F_6	138.50	9.18	147.67	3.17	0.36	2.09

S_2F_1	113.33	7.30	122.67	2.33	0.25	1.73
S_2F_2	120.00	7.63	129.00	2.93	0.30	1.90
S_2F_3	133.67	8.13	143.00	3.23	0.33	1.97
S_2F_4	135.67	8.47	145.33	3.50	0.34	2.03
S_2F_5	142.33	9.05	153.00	3.83	0.36	2.11
S_2F_6	144.33	10.40	155.67	4.07	0.38	2.26
S.Em.±	1.43	0.19	1.39	0.081	0.005	0.013
C.D. @ 5%	4.21	0.56	4.08	0.239	0.015	0.038

Conclusion

It can be finally concluded that the combination of closer spacing (45 x 30 cm) and higher dosage of 250:75:150 NPK kg/ ha was beneficial to get maximum flower and seed yield per ha. Whereas, wider spacing (60 x 30 cm) with 250:75:150 NPK kg/ ha best to get good vegetative growth, superior quality of flower in Bachelor's button cv.AGS-5.

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