Influence of nitrogen and potassium application on yield and quality of sweet william (*Dianthus barbatus* L) seed

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ABSTRACT

The present investigations were carried out at the experimental farm of Department of Seed Science and Technology, Dr Yashwant Singh Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh with the objective to work out optimum doses of nitrogen and potassium for better seed yield and quality of sweet william during 2017-18. The experiment was laid out in RBD (factorial) with 16 treatment combinations of four levels of nitrogen viz N_0 (0 g/m^2), N_1 (20 g/m^2), N_2 (30 g/m^2) and N_3 (40 g/m^2) and four doses of potassium viz K_0 (0 g/m^2), K_1 (10 g/m^2), K_2 (20 g/m^2) and K_3 (30 g/m^2) along with a constant dose of FYM @ 5 kg/m^2 and P @ 20 g/m^2 replicated thrice. Among different levels of nitrogen application of N_3 (N 40 g/ m^2) recorded maximum values for number of capsules per plant (98.36), number of seeds per capsule (49.20), seed yield per plot and per hectare (82.06 g and 820.58 kg respectively), 1000-seed weight (0.99 g), germination (92.69%), speed of germination (15.91), seedling length and dry weight (7.60 cm and 5.19 mg respectively), seed vigour index-I (704.83) and seed vigour index-II (481.36). The application of potassium 30 g/m^2 resulted in highest values for number of capsules per plant (88.64), number of seeds per capsule (45.10), seed yield per plot and per hectare (72.28 g and 722.75 kg respectively), 1000-seed weight (0.96 g), germination (91.06%), speed of germination (15.32), seedling length and dry weight (7.37 cm and 5.07 mg respectively), seed vigour index-I (672.43) and seed vigour index-II (464.13). The interaction N_3 (40 g/ m^2) × K_3 (30 g/m^2) recorded significantly maximum values in terms of the seed yield and quality parameters and effects were found to be significant. Therefore it is concluded that for getting maximum seed yield and producing better quality seeds the plants be fertilized with N:K 40:30 g/m^2 along with FYM 5 kg/m^2 and P 20 g/m^2.

Keywords: Nitrogen; potassium; sweet william; seed yield; seed quality

INTRODUCTION

Sweet william (*Dianthus barbatus* L) belongs to family Caryophyllaceae and is closely related to carnation and pinks. The sturdy sweet williams are native to the mountainous regions of the Pyrenes to the Balkans and have been cultivated for more than 400 years (Hermes 1997). It is an excellent plant for cut flowers, borders and beds as well as for growing as a pot plant. In the hills seeds of sweet william are sown in August to October and plants come into flowering during early summer (Swarup 1967). Sweet william is commercially propagated by seeds and there are number of factors which affect its seed yield and quality. The quality of seed is very much influenced by the application of nitrogen and potassium including other factors too. Optimum nitrogen has been found to improve the seed quality. Besides the application of potassium also plays a very important role in increasing the seed yield and improving seed quality. Therefore in order to increase seed yield and obtain better quality seeds there is an urgent need to standardize optimum doses of nitrogen and potassium in sweet william. The present investigations were thus undertaken to find out

the influence of nitrogen and potassium application on yield and quality of sweet william seed.

MATERIAL and METHODS

The present study was carried out at the experimental farm of Seed Science and Technology, Dr Yashwant Singh Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh. The experiment was laid out in RBD (factorial) with 16 treatment combinations of four levels of nitrogen viz N_0 (0 g/m^2), N_1 (20 g/m^2), N_2 (30 g/m^2) and N_3 (40 g/m^2) and four doses of potassium viz K_0 (0 g/m^2), K_1 (10 g/m^2), K_2 (20 g/m^2) and K_3 (30 g/m^2) along with a constant dose of FYM 5 kg/m^2 and P 20 g/m^2 replicated thrice. The healthy, bold, disease-free and uniform size seeds of sweet william were sown in the nursery. Each seed was covered with sieved well rotten FYM and watered properly.

The healthy, disease-free and stocky seedlings of uniform size and vigour at 5-6 leaf stage were selected and transplanted in the beds of 1 × 1 m size. Light irrigation was given soon after transplanting of seedlings. The plants were gently watered or irrigated daily during summer months and twice a week during winter in the entire cropping period. A full dose of potassium and phosphorus and half dose of nitrogen were applied at the time of field preparation and remaining half dose of nitrogen after 30 days of transplanting.

Observations were recorded on number of capsules per plant, number of seeds per capsule, seed yield per plot and per hectare, 1000-seed weight, germination percentage, speed of germination, seedling length and dry weight, seed vigour index-I and seed vigour index-II. The data recorded on various characters were subjected to statistical analysis as per randomized bock design (factorial) suggested by Panse and Sukhatme (1967) and in OPSTAT (http://hau.ernet.in/opstat.html).

RESULTS and DISCUSSION

The data on the influence of nitrogen and potassium application on yield and quality of sweet william seed are given in Table 1a and 1b.

Number of capsules per plant: Maximum number of capsules per plant (98.36) was recorded in the highest level of nitrogen N_3 (40 g/m^2) and minimum (54.88) in N_0 (0 g/m^2). This could be as a consequence of increased number of flowers produced in the plants receiving highest dose of nitrogen. The application of potassium 30 g/m^2 resulted in the highest number of capsules per plant (88.64) and minimum (65.08) was noticed in no application of potassium. This could be ascribed to the fact that application of higher doses of potassium resulted in the production of more number of flowers per plant which later on developed into capsules. The interaction N_3 (40 g/m^2) × K_3 (30 g/m^2) resulted in the production of maximum number of capsules per plant (105.20) and minimum (41.73) in N_0 (0 g/m^2) × K_0 (0 g/m^2). These results get support from the findings of Kaur and Kumar (1998) in pansy and Narayanan (2006) in phlox.

Number of seeds per capsule: The number of seeds per capsule was recorded maximum (49.20) in N_3 (40 g/m^2) and minimum (35.51) in N_0 (0 g/m^2). The development of more number of seeds per capsule under higher doses of nitrogen could be attributed to the increase in capsule size due to more accumulation of photosynthates in the capsules. The application of potassium 30 g/m^2 recorded highest number of seeds per capsule (45.10) and minimum (38.30) was found when no application of potassium was given. This could be attributed to the reason that higher dose of potassium might have increased carbohydrates production and their translocation to developing capsules. In case of interaction maximum number of seeds per capsule (51.33) was found in N_3 (40 g/m^2) × K_3 (30 g/m^2) and minimum (31.33) in N_0 (0 g/m^2) × K_0 (0 g/m^2). The results are in close conformity with the findings of Samoon and Kirad (2013) in calendula and Kumari (2016) in pansy.

Seed yield per plot: The higher dose of nitrogen N_3 (40 g/m^2) recorded maximum seed yield per plot (82.06 g) and minimum (44.01 g) was in the plots where no application of nitrogen was given. This might be due to more growth and spreading of plants and production of higher number of vegetative buds which later on turned into reproductive buds. The application of potassium 30 g/m^2 resulted in highest seed yield per plot (72.28 g) whereas minimum (52.93 g) was found with no application of potassium. This could be due to the fact that soil application of potassium might have produced quality flowers, stimulated pollination and fertilization as well thereby resulting in better seed setting and ultimately leading to production of more seed yield of better quality. In case of interaction maximum seed yield per plot (86.10 g) was recorded

Table 1a. Influence of nitrogen and potassium application on yield and quality of sweet william seed

Treatment	Number of capsules/plant	Number of seeds/capsule	Seed yield/plot (g)	Seed yield/ha (kg)
Nitrogen				
N_0	54.88	35.51	44.01	440.08
N_1	70.59	39.54	56.01	560.08
N_2	84.95	43.58	68.28	682.75
N_3	98.36	49.20	82.06	820.58
CD	2.02	0.85	1.49	14.88
Potassium				
K_0	65.08	38.30	52.93	529.25
K_1	73.35	40.86	58.87	588.67
K_2	81.71	43.57	66.28	662.83
K_3	88.64	45.10	72.28	722.75
CD	2.02	0.85	1.49	14.88
Interaction				
$N_0 \times K_0$	41.73	31.33	34.63	346.33
$N_0 \times K_1$	48.63	34.00	38.83	388.33
$N_0 \times K_2$	59.13	37.60	47.80	478.00
$N_0 \times K_3$	70.00	39.10	54.77	547.67
$N_1 \times K_0$	53.07	35.47	43.40	434.00
$N_1 \times K_1$	64.50	38.95	51.63	516.33
$N_1 \times K_2$	78.77	40.93	60.00	600.00
$N_1 \times K_3$	86.03	42.80	69.00	690.00
$N_2 \times K_0$	73.90	40.00	56.80	568.00
$N_2 \times K_1$	83.47	41.93	63.87	638.67
$N_2 \times K_2$	89.10	45.23	73.20	732.00
$N_2 \times K_3$	93.33	47.17	79.23	792.33
$N_3 \times K_0$	91.60	46.40	76.87	768.67
$N_3 \times K_1$	96.80	48.57	81.13	811.33
$N_3 \times K_2$	99.83	50.50	84.13	841.33
$N_3 \times K_3$	105.20	51.33	86.10	861.00
CD	4.05	1.71	2.98	29.75

N_0: 0 g/m^2, N_1: 20 g/m^2, N_2: 30 g/m^2, N_3: 40 g/m^2, K_0: 0 g/m^2, K_1: 10 g/m^2, K_2: 20 g/m^2, K_3: 30 g/m^2

with the combined application of N_3 (40 g/m^2) and K_3 (30 g/m^2). However minimum seed yield per plot (34.63 g) was observed in the interaction N_0 (0 g/m^2) × K_0 (0 g/m^2). These results are in close conformity with the findings of Kumar and Kaur (1996) in balsam and Narayanan (2006) in phlox.

Seed yield per hectare: Seed yield per hectare was recorded to be maximum (820.58 kg) with the application of N_3 (40 g/m^2) and minimum (440.08 kg) in N_0 (0 g/m^2). It was noted to be highest (722.75 kg) with the application of potassium 30 g/m^2 and minimum (346.33 kg) with no application of potassium K_0. This might be due to the application of optimum doses of nitrogen and potassium that resulted in higher vegetative growth of the plants and ultimately led to production of more capsules per plant as well as more number of seeds per capsule and hence higher seed yield per hectare. Maximum seed yield per hectare (861.00 kg) was recorded in the interaction N_3 (40 g/m^2) × K_3 (30 g/m^2) and minimum (346.33 kg) in N_0 (0 g/m^2) × K_0 (0 g/m^2). These results are in close agreement with the findings of Samoon and Kirad (2013) in calendula and Kumari (2016) in pansy.

1000-seed weight: Maximum 1000-seed weight (0.99 g) was recorded in N_3 (40 g/m^2) and minimum (0.89 g) in no application of nitrogen. This might be as a result of better growth and flowering of plants which ultimately led to production of bold and better quality seeds. The highest 1000-seed weight (0.96 g) was reported with the application of potassium 30 g/m^2 and minimum (0.92 g) in K_0 (0 g/m^2). This might be due to the fact that potassium plays an important role in increasing the cell division and transferring assimilatory materials into seeds. The interaction N_3 (40 g/m^2) × K_3 (30 g/m^2) resulted in maximum 1000-seed weight (1.00 g) whereas minimum (0.86 g) was recorded in

Table 1b. Influence of nitrogen and potassium application on yield and quality of sweet william seed

Treatment	1000-seed weight (g)	Germination (%)	Speed of germination	Seedling length (cm)	Sedling dry weight (mg)	SVI-I	SVI-II
Nitrogen							
N_0	0.89	84.44	12.99	5.46	3.00	462.16	254.18
N_1	0.93	87.44	14.17	6.90	3.93	604.17	345.86
N_2	0.96	90.50	15.14	7.00	4.34	634.19	394.21
N_3	0.99	92.69	15.91	7.60	5.19	704.83	481.36
CD	0.01	0.03	0.11	0.03	0.01	4.38	2.62
Potassium							
K_0	0.92	86.50	13.82	6.25	3.20	543.19	280.00
K_1	0.93	87.88	14.22	6.43	3.65	567.98	324.04
K_2	0.95	89.63	14.85	6.91	4.52	621.75	407.44
K_3	0.96	91.06	15.32	7.37	5.07	672.43	464.13
CD	0.01	0.03	0.11	0.03	0.01	4.38	2.62
Interaction							
$N_0 \times K_0$	0.86	82.00	12.15	4.75	2.23	389.45	182.45
$N_0 \times K_1$	0.88	83.75	12.65	5.05	2.57	422.52	215.03
$N_0 \times K_2$	0.90	85.00	13.04	5.62	3.36	477.92	285.39
$N_0 \times K_3$	0.92	87.00	14.12	6.42	3.84	558.77	333.87
$N_1 \times K_0$	0.89	84.25	13.04	6.97	2.87	587.38	241.83
$N_1 \times K_1$	0.91	85.25	13.41	6.35	3.36	542.08	286.51
$N_1 \times K_2$	0.95	89.00	14.91	6.92	4.42	615.66	393.16
$N_1 \times K_3$	0.96	91.25	15.31	7.35	5.06	671.53	461.92
$N_2 \times K_0$	0.94	87.75	14.43	6.33	3.46	554.93	303.12
$N_2 \times K_1$	0.95	90.25	15.01	6.76	3.77	610.88	340.33
$N_2 \times K_2$	0.97	91.75	15.50	7.24	4.66	663.90	426.94
$N_2 \times K_3$	0.98	92.25	15.63	7.66	5.49	707.05	506.45
$N_3 \times K_0$	0.98	92.00	15.68	6.97	4.27	641.01	392.61
$N_3 \times K_1$	0.98	92.25	15.81	7.54	4.92	696.43	454.28
$N_3 \times K_2$	0.99	92.75	15.94	7.87	5.66	729.52	524.26
$N_3 \times K_3$	1.00	93.75	16.21	8.03	5.92	752.38	554.27
CD	0.02	0.06	0.22	0.06	0.02	8.76	5.25

N_0: 0 g/m^2, N_1: 20 g/m^2, N_2: 30 g/m^2, N_3: 40 g/m^2, K_0: 0 g/m^2, K_1: 10 g/m^2, K_2: 20 g/m^2, K_3: 30 g/m^2

N_0 (0 g/m^2) × K_0 (0 g/m^2). These results are in consonant with the findings of Rahmani et al (2009) in calendula and Kumari (2016) in pansy.

Germination: Highest germination (92.69%) was recorded with N_3 (40 g/m^2) and minimum (84.44%) from the plants where no nitrogen was applied. This might be due to the reason that with the application of higher dose of nitrogen the seed protein content also increased which resulted in higher germination. The maximum germination (91.06%) was observed with the application of K_3 (30 g/m^2) and minimum (86.50%) in plants which did not receive application of potassium. This might be due to the fact that potassium activates some enzymes in the seeds that induce the process of germination. The interaction N_3 (40 g/m^2) × K_3 (30 g/m^2) exhibited maximum germination (93.75%) and minimum (82.00%) was noted in N_0 (0 g/m^2) × K_0 (0 g/m^2). The results are in line with the findings of Narayanan (2006) in phlox.

Speed of germination: Maximum speed of germination (15.91) was recorded in N_3 (40 g/m^2) and minimum (12.99) was observed when no application of nitrogen was given. The highest speed of germination (15.32) was reported with the application of potassium 30 g/m^2 and minimum (13.82) in K_0 (0 g/m^2). This might be due to the fact that application of nutrients at higher rates activates some hydrolytic enzymes in the seeds and favours the early emergence of seedlings. The interaction N_3 (40 g/m^2) × K_3 (30 g/m^2) resulted in maximum speed of germination (16.21) whereas minimum (12.15) was recorded in the interaction N_0 (0 g/m^2) × K_0 (0 g/m^2). These results are in consonant with the findings of Narayanan (2006) in phlox.

Seedling length: Maximum seedling length (7.60 cm) was observed in N_3 (40 g/m^2) and minimum (5.46 cm) in N_0 (0 g/m^2). The maximum seedling length (7.37 cm) was reported in potassium dose of 30 g/m^2 and minimum (6.25 cm) in no application of potassium. This

might be due to more production of proteins and carbohydrates as well as enzymes with the application of higher doses of K which activated the metabolites in the seeds and resulted in emergence of better quality and taller seedlings. The interaction N_3 (40 g/m^2) × K_3 (30 g/m^2) exhibited highest seedling length (8.03 cm) and minimum (4.75 cm) was found in N_0 (0 g/m^2) × K_0 (0 g/m^2). Similar results have been reported by Narayanan (2006) in phlox and Kumari (2016) in pansy.

Seedling dry weight: Seedling dry weight was recorded to be maximum (5.19 mg) in nitrogen @ 40 g/m^2 and minimum (3.00 mg) in N_0 (0 g/m^2). The maximum seedling dry weight (5.07 mg) was observed in potassium 30 g/m^2 (K_3) and minimum (3.20 mg) in no application of potassium. This might be due to the reason that nutrients applied at adequate amount resulted in activation of some enzymes and metabolites in growing points and production of bold and healthy seedlings which ultimately increased the seedling dry weight. The interaction N_3 (40 g/m^2) × K_3 (30 g/m^2) recorded maximum seedling dry weight (5.92 mg) and it was found to be minimum (2.23 mg) in the interaction N_0 (0 g/m^2) × K_0 (0 g/m^2). The results get support from the findings of Narayanan (2006) in phlox.

Seed vigour index-I (SVI-I): Maximum seed vigour index-I (704.83) was reported in nitrogen 40 g/m^2 and minimum (462.16) in N_0 (0 g/m^2). The maximum seed vigour index-I (672.43) was observed in potassium 30 g/m^2 whereas minimum (543.19) in no application of potassium (K_0). This might be attributed to the reason that application of nitrogen at higher levels produced plants with good quality seeds in terms of better seed germination and improved seed vigour. Under interaction effect maximum seed vigour index-I (752.38) was obtained in N_3 (40 g/m^2) × K_3 (30 g/m^2) and minimum (389.45) in N_0 (0 g/m^2) × K_0 (0 g/m^2). These results get support from the earlier work of Kumari (2016) in pansy.

Seed vigour index-II (SVI-II): Maximum seed vigour index-II (481.36) was recorded in N_3 (40 g/m^2) and minimum (254.18) in N_0 (0 g/m^2). For potassium maximum seed vigour index-II (464.13) was observed with the application of potassium 30 g/m^2 and minimum (280.00) in no application of potassium. This might be due to the reason that higher doses of nutrients induced the formation of requisite proteins and enzymes in adequate quantity which would have acted on the metabolites in seeds and resulted in development of vigorous seedlings. As regards the interaction maximum seed vigour index-II (554.27) was obtained in N_3 (40 g/m^2) × K_3 (30 g/m^2) and minimum (182.45) in N_0 (0 g/m^2) × K_0 (0 g/m^2). These findings are similar to those of Narayanan (2006) in phlox and Kumari (2016) in pansy.

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