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Effect of spacing on seed yield and quality in phlox. *(Phlox drummondii. cv. Globe mix)*

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Abstract
Phlox, a genus of some 60 species of herbaceous perennials, hardy and half-hardy, sub-shrub, and annuals. Most of which are native to North America and Mexico, and grown for their showy flowers. Phlox belonging to Polemoniaceae. According to Walter (1933) [9], Annual phlox, *Phlox drummondii* is an American plant with purple flowers introduced in 1835. It has been completely eclipsed by the garden forms and is rarely seen. There are three types: the grandiflora or large flowered, height about 1 ft, the nana compact or dwarf compact, height 6-8 in., and the cuspidata or point-petalled. Seed production in this flower crop is a highly specialised task warranting expertise technical knowledge, frequent and timely attention compared to other commercial crops. The work on seed production, processing, storage and germination aspects are lacking. Several technological gaps are yet to be filled up for getting good quality seeds in this flower crop. With this background, a field experiment was carried out to study the influence of different spacing (20 × 10 cm, 20 × 20 cm, 30 × 10cm, 30 × 20 cm and 40 × 10 cm, 40 × 20 cm) on seed yield quality in phlox. The study revealed that a spacing of 40 × 10 cm recorded the highest seed yield of 115.3 kg ha^{-1} with maximum germination of 89.5 per cent.

Keywords: Phlox, Spacing

Introduction
India is blessed with scenic grandeur and a panorama of constrasting landscape with its unparalleled colours and moods. No other country in the world has got so much of diversity of climate and soil which exists in this land of lofty mountains and mighty rivers. Because of this it is possible to grow all kinds of flower crops. The art and science of growing flowering plants is not new to India and dates back to 3000 B.C. Methods of plant multiplication by seed and vegetative means were prevalent and find mention in the Vedas, Arthasasthra and Brhat Samhita (3000-2000 B.C.). Phlox drummondii in an annual flower crop, which was introduced from America in 1835 (Walter, 1933) [9]. There are time types viz, the grandiflora, nana compacts and the cuspidate. A bed of mixed seedling in exceedingly pretty and in view of the simplicity of culture and long period during which the plants are in bloom it is surprising that the plant enjoy great favour. Several technological gaps are yet to be filled up for getting good quality seeds in this flower crop. The major constraints in annual flower seed production are non-availability of information on various aspects of seed production such as spacing, manuring and foliar spray effect (Tomar, 1998) [10]. Hence, the present experiment was formulated to study the influence of spacing on yield and quality of phlox seeds.

Materials and Methods
The uniformly graded phlox seeds were sown in the raised nursery beds. Thirty five days old seedlings were pulled from the nursery and transplanted in the main field in the Horticulture Research Station, Udhagamandalam adopting randomized block design with four replications with all recommended package of practice. The following spacing were adopted like 20 × 10 cm, 20 × 20 cm, 30 × 10 cm, 30 × 20 cm, 40 × 10 cm, 40 × 20 cm. In each treatment, five plants were tagged at random for biometrical observations. like days to first flowering, days to 50% flowering, number of branches per plant^{-1}, plant height, Pod number per plant, pod yield per plant, pod yield per plot. Pod yield per ha, seed yield per plant, seed yield per plot, seed yield per ha and seed recovery. The seeds obtained from each treatment were size graded using BSS 16X16 wire mesh sieve and retained seeds were used for seed quality assessment. The germination test was conducted in four replicates of 100 seeds each in paper medium and allowed to germinate at 25±2 ºC and 90±2 percent relative humidity. After 14 days, the seedlings were evaluated and expressed as germination percent. Ten normal seedlings from each replication were measured for root and shoot length. These seedlings were than dried in hot air oven maintained at 85±9 ºC to record the dry weight. Vigour index values were

computed by multiplying germination % and seedling length. The data obtained were subjected to statistical analysis.

Results and Discussion

Adoption of plant geometry is another important agronomic factor that contributes to higher yield and the multifaceted seed quality (Alexalbert, 2007) [2]. Ponnuswamy and Rangasamy (1996) [7] opined that for getting higher seed yield and quality, maintenance of adequate plant density is vital as it determines the yield per unit area. Optimum plant density is required for complete use of environmental conditions (water, air, light and soil) by the plants and also to minimize the inter or intra- specific competition (Sadeghi *et al.,* 2009) [8]. Success in absorption of nutrients from soil depends on the spacing adopted for production. Hence, adequate supply of nutrients under correct crop spacing becomes important for obtaining higher seed yield. The seed has to face enormous amount of pressure from environment, edaphic and biotic factors during the course of its development and maturation and only those, which would over come all these forces, would attain the expected level of quality at the time of harvest. Many times without the help of man, the mother plant may not be in a position to over come all the adversities during entire cropping period. In the present study the plant height (36.1cm) and early flowering (39 days and 52 days) was recorded in closer spacing (20 × 20 cm). This might be due to the fact that in closes spacing plants tend to grow vertically for more light and resulted in early flowering. In the present investigation, the plants from wider spacing (40 x 10 cm) registered more pod number plant^{-1}(188.2), pod yield plant^{-1}(2.47), pod yield plot^{-1}(16.92g), pod yield ha^{-1}(169.2Kgs), seed yield plant^{-1}(1.70g), seed yield plot^{-1}(11.53g), seed yield ha^{-1}(115.31 Kg) (Table 2&3). It might be attributed that wider spacing provides more opportunity for proper growth and development of individual plants by making available more of solar radiation, moisture, plant nutrients, space and other growth promotive possible due to more number of branches leaf area and dry matter production per plant and efficient translocation of photosynthates into sink (Jadhav *et al*. 1994) [4]. The resultant seed obtained from wider spacing (40 x 10) registered higher germination(89.5), root length(6.0cm), shoot length(5.6cm), dry matter production(0.034g per 10 seedlings) and vigour index(1002) were higher in plants received DAP at 1% spray (Table.4). Increased germinability and vigour recorded at wider spacing might be because of increased seed weight and higher protein content. The study on the influence of spacing revealed that a spacing of 40 x 10 cm recorded the highest seed yield of 115.31 kg ha^{-1} with maximum germination of 89.5 per cent.

Table 1: Effect of different spacing on plant height, number of branches and days to flowering in Phlox cv. Globe Mix

Treatments	Plant Height (cm)	Number of branches plant^{-1}	Days to First Flowering	Days to 50% Flowering
T_1-20X10 cm	20.9	6	41	56
T_2-20X20 cm	36.1	8	39	52
T_3-30X10 cm	30.3	8	44	58
T_4-30X20 cm	35.3	10	40	56
T_5-40X10 cm	31.1	7	40	54
T_6-40X20 cm	31.8	9	41	56
SE(d)	1.44	1.06	1.30	1.37
CD(P=0.05)	3.06**	2.27**	2.77*	2.93**

Table 2: Effect of different spacing on pod and seed yield in P*hlox cv. Globe Mix*

Treatments	Pod number plant^{-1}	Pod yield (kg ha^{-1})	Seed yield (g plant^{-1})	Seed yield (kg ha^{-1})	Seed recovery (%)
T_1-20X10 cm	146.2	142.8	1.51	97.11	91.9 (73.5)
T_2-20X20 cm	161.8	168.1	1.54	105.31	92.9 (74.6)
T_3-30X10 cm	160.5	159.0	1.52	105.09	92.4 (74.0)
T_4-30X20 cm	172.8	156.3	1.67	115.10	93.7 (75.4)
T_5-40X10 cm	188.2	169.2	1.70	115.31	92.6 (74.3)
T_6-40X20 cm	155.5	149.5	1.48	99.14	93.9 (75.7)
SE(d)	5.22	5.69	0.047	4.05	0.77
CD(P=0.05)	11.12**	12.13**	0.10**	8.63**	NS

Figures in the paranthesis indicate arc sine values

Table 3: Resultant seed germination, seedling length, dry weight and vigour at different spacing in Phlox cv. Globe Mix

Treatments	Germination (%)	Root length (cm)	Shoot length (cm)	Drymatter Production (g Seedlings^{-10})	Vigour Index
T_1-20X10 cm	80.5 (63.9)	3.8	3.7	0.025	597
T_2-20X20 cm	86.5 (68.5)	5.7	5.2	0.032	966
T_3-30X10 cm	84.5 (66.9)	4.2	4.0	0.031	690
T_4-30X20 cm	88.5 (70.3)	5.3	5.0	0.031	926
T_5-40X10 cm	89.5 (71.2)	6.0	5.6	0.034	1002
T_6-40X20 cm	87.0 (68.9)	5.8	4.9	0.032	936
SE(d)	2.15	0.31	0.21	0.001	39.06
CD (P =0.05)	4.58**	0.69**	0.45**	0.003**	87.00**

Figures in the paranthesis indicate arc sine values

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