Research Note

Effect of Plant Density on Seed Yield and its Components in China Aster (*Callistephus chinensis* (L.) Nees.) cv. Kurenai and Powderpuff.

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ABSTRACT

A radial trial design was used to determine the effects of plant density on seed yield in a medium height (Kurenai) and a tall (Powderpuff) cultivar of China aster. Seed yield per plant decreased as plant density increased because of a reduction in seed heads per plant in cv. Kurenai and all seed yield components in cv. Powderpuff. Maximum seed yield was achieved at 27.8 plants m^{-2} for cv. Kurenai and 17.3 plants m^{-2} for cv. Powderpuff, but there were no significant differences in seed yield among densities ranging from 12.7 to 44.7 plants m^{-2} for the former, and 4.9 to 44.7 plants m^{-2} for the latter cultivar.

EXPERIMENTAL AND DISCUSSION

Kobza (1987) reported that seed yield of China aster (*Callistephus chinensis* (L.) Nees). increased as plant density increased, but that optimum density varied with cultivar. Optimum plant spacing recommendations have ranged from 30-40 x 30-40cm for taller cultivars to 15-20 x 15-20 cm for dwarf cultivars (Salunkhe, Desai and Bhat, 1987), but little information exists for many cultivars. In 1987/88 the radial spacing design type Ia of Nelder (1962) was selected to determine the effect of plant density on seed yield and its components in two China aster cultivars, Kurenai, a medium height (45-50cm) single flower type and Powderpuff, a tall (75-80cm) double flowered type (Phetpradap, 1992). Thirty-day old glasshouse grown seedlings were transplanted into the field on 21 November 1987 (cv. Kurenai) and 16 December 1987 (cv. Powderpuff). Two full circles (Nelder 1962, Bleasdale 1967) were planted out for each cultivar. Each circle contained 80 radii and 22 concentric arcs, with each arc representing one plant density, ranging from 3.1 plants m^{-2} at the outer most arc to 83.9 plants m^{-2} at the inner most arc. The four inner most and two outer arcs were used as borders, leaving populations which ranged from 4.2 to 44.7 plants m^{-2}. Details of the site and experimental management have been provided by Phetpradap (1992).

Each radial trial was divided into four replicate sections, each containing 20 radii. Seed yield was obtained by the hand harvesting (cutting at ground level) of 16 plants per density per section on 22 March 1988 for cv. Kurenai, and 8 plants per density per section on 18 April 1988 for cv. Powderpuff. Problems with lodging and *Fusarium* foot rot in the latter cultivar meant there were fewer plants available to harvest (Phetpradap, 1992). At harvest, seed moisture content (SMC) was around 40% for both cultivars. Harvested plant material was ambient air dried for two weeks, following which seed heads were hand removed from the plants. The number of seed heads per plant was counted from four plants per replicate chosen at random, and seed number per seed head determined from 20 randomly chosen seed heads per replicate. Seed heads were then threshed by a brush thresher (Thrige-Tital Asea. Cat. No. MkIII 813B) and cleaned using a laboratory sized Clipper seed cleaner with a 1.40 mm round perforation screen. Thousand seed weight and germination were determined using internationally approved methodology (ISTA, 1985). Final seed yield expressed at 7% SMC was fitted to the yield-density function of Holliday (1960), using a quadratic reciprocal equation (Phetpradap, 1992). Residuals from this equation were also plotted to ensure that the variations were random (Pearce, 1983). Regression coefficients were calculated to evaluate the association between seed yield and its components.

Increasing plant density decreased per plant performance (Table 1). In cv. Kurenai, seed yield per plant decreased significantly among the four populations for which data are presented (Table 1), primarily because of the significant decline in seed heads per plant. Seeds per seed head did not differ significantly, while thousand seed weight only differed at the higher plant densities. In cv. Powderpuff yield decreased significantly as plant population increased from 5.8 to 10.8 and 20.3 plants m^{-2} (Table 1), but did not differ at 20.3 and 38.2 plants m^{-2}. Seed heads per plant also fell significantly, and there were also significant differences in seeds per seed head and thousand seed weight among some of the populations.

Both cultivars showed a parabolic seed yield per unit area relationship with plant density (Figure 1), with a maximum yield of 140 gm^{-2} from 27.8 plants m^{-2} for cv. Kurenai and 42 g m^{-2} from 17.3 plants m^{-2} for cv. Powderpuff. These densities were very similar to those reported as optimal by Kobza (1987) for a relatively short bedding cultivar (40 x 10 cm spacing = 25 plants m^{-2}) and a tall

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cutting cultivar (40 x 15 cm plant spacing = 16 plants m^{-2}). However, there were no significant seed yield differences from plant densities ranging from 12.7 to 44.7 plants m^{-2} in cv. Kurenai, or among all densities apart from the lowest (4.2 plants m^{-2}) in cv. Powderpuff (Figure 1) because reductions in seed heads per plant, seeds per seed head and often thousand seed weight (Table 1, Figure 1) were compensated for by the increase in plant numbers, the net effect being no significant change in seed yield.

Of the seed yield components, flower number (Table 1) explained 88 and 91% respectively of the variation in seed yield. For cv. Kurenai this was also the case for seed head number (76%), but not for cv. Powderpuff (39%), because in this cultivar flowering continued through until harvest, particularly at lower plant densities, and therefore many of the seed heads had not ripened or did not contain mature seeds.

Table 1. Effect of plant density[1] on seed yield components and seed yield per plant in China aster cv. Kurenai and Powderpuff.

Plants m^{-2}	Flowers plant[2]	Seed heads $plant^{-1}$	Seeds seed $head^{-1}$	TSW (g)	Seed yield $plant^{-1}$ (g)
a) cv. Kurenai					
5.8	85	66	133	1.60	12.6
10.8	71	62	128	1.60	9.4
20.3	50	39	123	1.59	6.2
38.2	30	24	120	1.57	3.3
LSD $P<0.05$[3]	9	7	24	0.06	2.9
%CV	11.3	8.9	11.5	2.2	10.6
b) cv. Powderpuff					
5.8	59	43	64	2.20	6.3
10.8	43	31	56	2.01	3.7
20.3	26	21	55	2.00	2.0
38.2	17	12	46	2.04	1.4
LSD $P<0.05$[3]	10	8	8	0.13	1.7
%CV	13.1	16.9	19.5	3.8	14.8

[1] data selected to represent low, medium, high and very high plant densities (Phetpradap, 1992).
[2] at peak flowering (includes buds).
[3] for all 16 densities.

This trial has demonstrated, that as for many other species, similar seed yields of China aster can be obtained from a wide range of populations. The population used for seed production may therefore be decided by other management requirements; for example sowing or transplanting machinery design, the requirement for movement through the growing crop for weed, pest and disease control, and if mechanical harvesting is an option, the need for even maturation of flower heads distributed at a similar height within the crop, as produced by the high (*eg* 38.2 plants m^{-2}) densities for both cultivars (Phetpradap, 1992).

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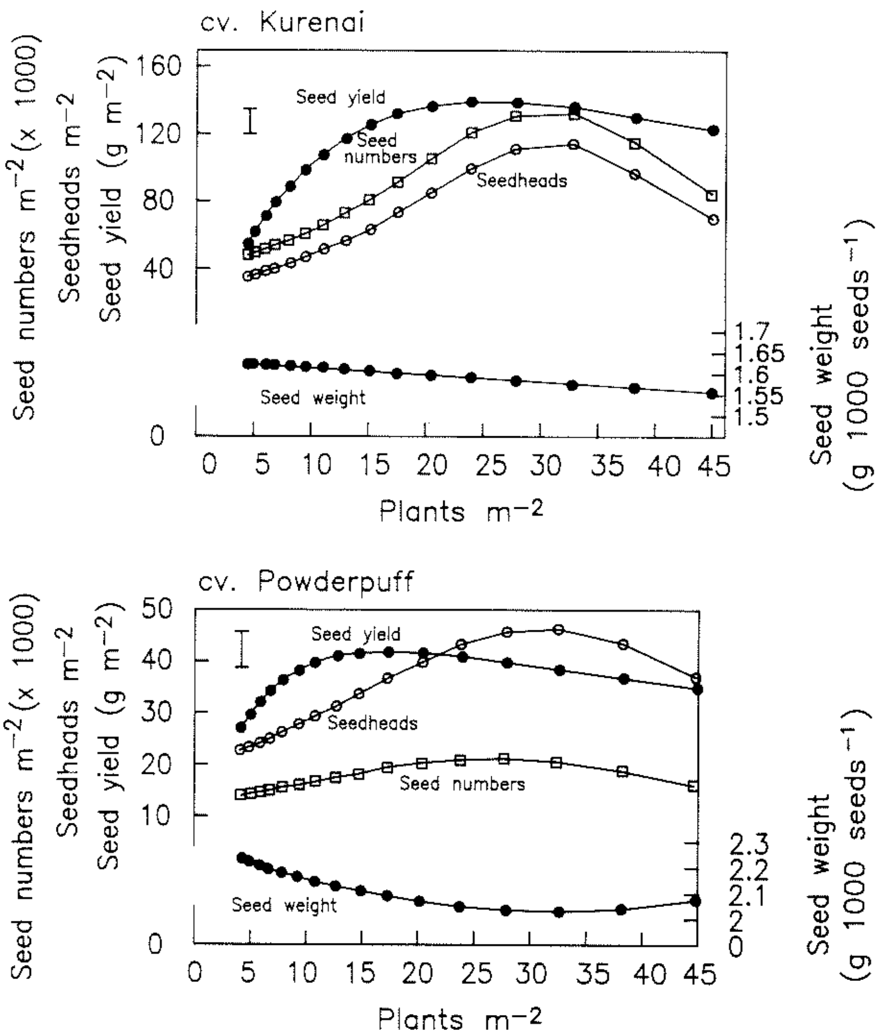
Figure 1.
Effect of plant density on seed yield (g m^{-2}) and its components in China aster cv. Kurenai and Powderpuff.



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