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# GROWTH PERFORMANCE AND DRY MATTER YIELD OF *CASSIA TORA* L. AS INFLUENCED BY POPULATION DENSITY

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## Introduction

*Cassia tora* L. is a gregarious species and often forms pure and dense stands during rainy season on ruderal habitats and grazing grounds. Plants growing in such stands may be subjected to intraspecific competition hence may exhibit variations in growth performance. To investigate this point the present study was undertaken and the effect of population density on growth performance and dry matter yield has been assessed. This opportunity was also utilised for evaluation of the organic production on ruderal habitats dominated by this species. In India, studies on production ecology have been initiated only recently (Misra, 1967; Misra *et al.*, 1967; Singh, 1967) and no data appear to have been recorded so far, for such habitats.

## Material and Methods

A number of quadrats (30×30 cm.) was laid at random within the *C. tora* stands growing in open fields near Banaras Hindu University during the third week of September 1966 and number of plants in each quadrat was counted. Three plants from each quadrat were sampled and the following observations were recorded: diameter at the base of stem, height, lateral spread, number of branches, number of flowers and number of fruits. The plants were then dug out and after washing the root systems with a fine jet of water, length and lateral spread of roots were measured. Dry weights of shoots and roots were also determined after drying the samples at 105° C. for 24 hours. In the case of quadrats with only one plant, the number was increased so as to sample equal number of plants. The values obtained are grouped according to the density of population.

## Results

*Morphological features.*—It is evident that the diameter of stem at the base declines with an increase in the density of population over 10 plants/quadrat. The decline is most conspicuous between densities

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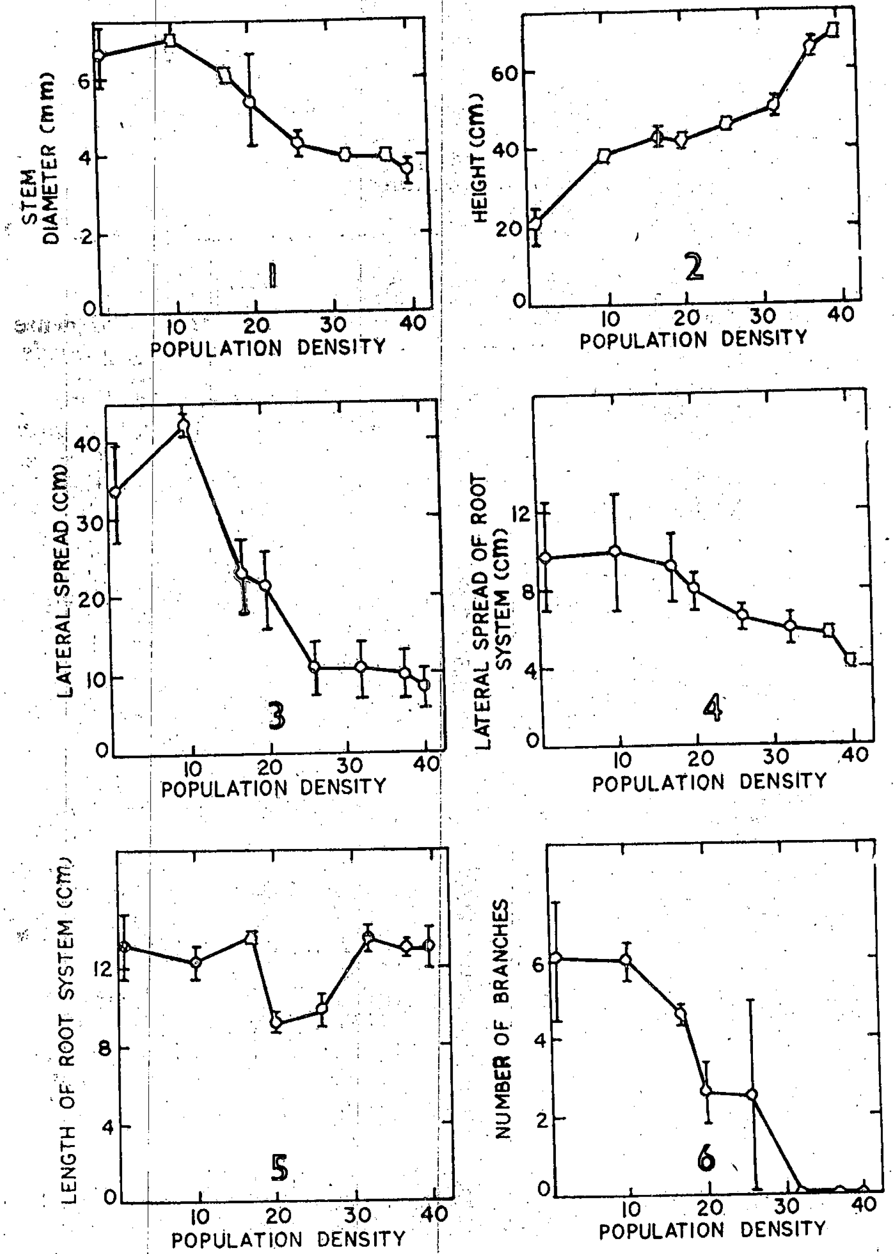



FIGS. 1–6. Effect of population density on morphological features of *Cassia tora* L. Vertical bars represent standard deviation.

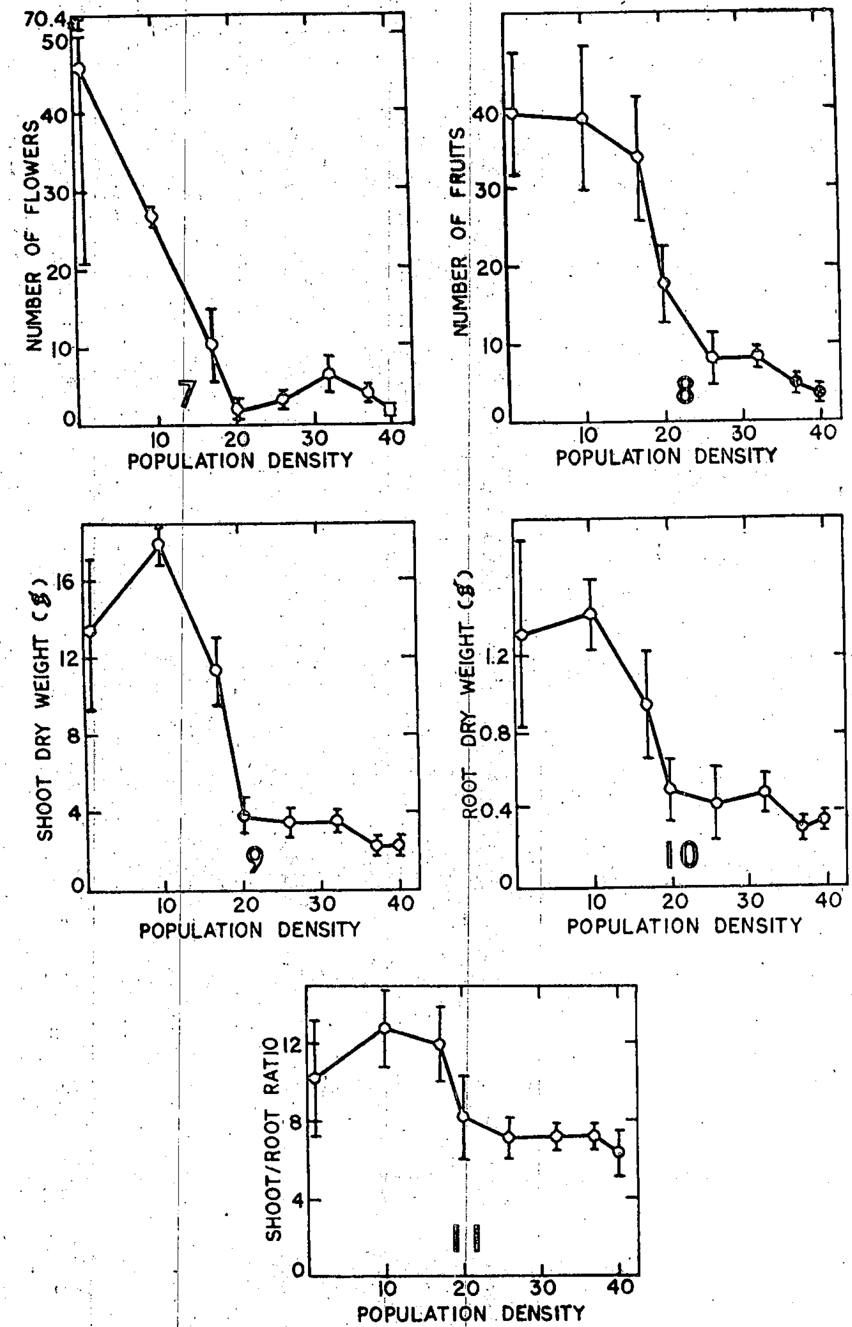
of 17 plants/quadrat to 26 plants/quadrat. The minimum value, however, is obtained for plants growing in quadrats with the density of 40 plants (Fig. 1). Height of the plants exhibit positive relation with density. The plants are considerably taller in quadrats with high densities. Maximum height is recorded for plants sampled from quadrats having 40 plants in each of them and minimum for plants growing isolated (Fig. 2). Lateral spread of plants after exhibiting a slight increase with increase in density from 1 to 10 plants/quadrat, declines to the minimum value for quadrats with a density of 40 (Fig. 3). Lateral spread of root systems decreases gradually with an increase in the population density over 10 plants/quadrat (Fig. 4). Length of the root system is not affected to any considerable extent by variation in the density of population (Fig. 5). Number of branches in the shoot decreases from 6·1 in isolated plants to 2·5 in plants growing in areas with a density of 26 plants/quadrat. Further increase in density completely suppresses branching (Fig. 6). There is a conspicuous decrease in the number of flowers after density increases beyond 10 plants/quadrat. The values fluctuate and remain considerably lower from a density of 20 to 40 plants/quadrat (Fig. 7). Number of fruits per plant also decreases with an increase in the population density and the values range from 39·4 flowers (isolated plants) to 3·6 flowers (density 40 plants/quadrat) (Fig. 8).

*Dry matter yield.*—Both the dry weights of shoots and roots decrease with the increase in population density beyond 10 plants/quadrat (Figs. 9, 10). The decrease, however, is much conspicuous after the population density increases from 17 to 20 plants/quadrat, the values remaining considerably lower upto 40 plants/quadrat. Shoot/root ratio is also lower in plants growing with higher density beyond 17 plants/quadrat (Fig. 11).

## Discussion

The existence of intraspecific competition within *C. tora* population is clearly demonstrated through the effect of increasing population density on morphological features, flower and fruit production, and dry matter yield. Decrease in the stem diameter, number of branches, lateral spread of shoot and lateral spread of root systems with increasing population density reflects overcrowding for available space. Increase in the height of plants with increase in the density appears to be a response to competition for light. Norman (1960) has also reported that plants become taller in response to the shade cast by their neighbours. Studies on the role of light in interspecific and intraspecific competition have been amply reviewed by Saeki (1963). Crowding effect is also manifested in a decrease in reproductive potential as evidenced by data on flower and fruit production.

Salisbury (1942) has discussed the suppressive effect of competition on the production of seeds and fertile fruits in a number of species. In *Ranunculus bulbosus*, number of fertile carpels per plant varies from 687 (no competition) to 69 (severe competition). Based on these studies he (Salisbury, *loc. cit.*) opines, "we have thus seen




FIGS. 7–11. Effect of population density on the dry matter yield and shoot/root ratio of *Cassia tora* L. Vertical bars represent standard deviation.

that for a species which occurs normally as a constituent of a closed community the removal of the competition factor may increase the reproductive capacity nearly ten times." In *C. tora*, however, when the number of fruits produced on area basis is examined, an increase is encountered upto a density of 17 plants/quadrat (Table) after which the value decreases. Thus it appears that the magnitude of competition becomes sufficient to suppress the production of fruits only after the density crosses 17 plants/quadrat.

Plant growth progresses through the interaction between physiological functions and environmental factors (Kuroiwa, 1960) and it integrates the situation when plants compete for factors like nutrients, water, light, either simultaneously or in rapid succession (Bleasdale, 1960). Such integrating procedure has led to a better understanding of density effect, interspecific and intraspecific competition (*see* Kuroiwa, 1960). Accordingly, the dry matter production or plant weight (Bleasdale, 1960) is taken as a good index of the outcome of competition. In the species presently studied, it is indicated from the dry matter yield of shoots and roots of plants growing in areas which differ in population density, that density beyond 17 plants/quadrat has a conspicuous deleterious effect. The effect, however, is more pronounced on shoot dry weight as indicated by decreasing shoot/root ratio.

In this context, the dry matter production by this species on area basis has also been considered. The values have been computed with the help of plant dry weights and density. Since this plant is a rainy season annual, the biomass at the end of the growing season can be taken as net primary production. It is evident from table that increase in the density upto 17 plants/quadrat results in corresponding increase both in the aboveground and the underground dry matter production. The maximum production of 2306 g./sq. m. is far greater as compared to the production in the grasslands of the nearby area (742 g./sq.m.; Singh, 1967) and of the temperate grasslands (Singh, *loc. cit.*). This plant, therefore appears to be of high productive potential in as much as it produces more dry matter within about 3 months time (July to September) than the perennial grass communities do in a year.

TABLE

*Effect of population density on the production of fruitsand dry matter*

| Density* | No. of fruits/ quadrat | Dry matter | | Total (g./m.²) |
|---|---|---|---|---|
| | | Aboveground (g./m.²) | Underground (g./m.²) | |
| 1 | 39·4 | 147·98 | 14·55 | 162·53 |
| 10 | 391·0 | 1985·30 | 152·22 | 2137·52 |
| 17 | 571·2 | 2128·57 | 177·48 | 2306·05 |
| 20 | 352·0 | 22·20 | 113·20 | 935·40 |
| 26 | 215·8 | 990·86 | 118·30 | 1109·16 |
| 32 | 272·0 | 1269·12 | 174·08 | 1443·20 |
| 37 | 185·0 | 888·00 | 123·21 | 1011·21 |
| 40 | 144·0 | 1008·80 | 155·20 | 1164·00 |

* Number of plants/quadrat of 30×30 cm.

Moreover, the species invades the ruderal habitats and floors of the deciduous forests, where only a few selected species can grow well. The study, therefore, indicates the possibility of immense economic exploitation of this species.

The influence of population density on the yield of *C. tora* raises certain interesting problems. The observation that increase in the density beyond a certain point results in a decrease in dry weight of individual plants is in conformity with other reports as reviewed by Harper (1961) and Donald (1961). According to Harper (1961), "The yield of a crop is not a linear function of the density of seed sown because over a wide range of densities further increase brings diminishing returns." He (Harper, *loc. cit.*) further concludes, "In general the total yield of dry matter produced per unit area tends to increase to an asymptote or to a constant plateau with increasing density of plants..". Donald (1961) also opines, "There is no indication that the total yield of dry matter per unit area will fall even with extremely high population densities." In *C. tora*, it is seen that after attaining maximum biomass at a density of 17 plants per 30×30 cm. area, the total dry matter production declines considerably. However, in the density range of 26 to 40 plants per 30×30 cm. area the values of dry matter production fluctuate and are confined between 1011·21 g. and 1443·20 g./sq.m. Therefore, in this plant it appears that after the peak production, the dry matter yield is decreased and then only the production becomes static so that further increase in density fails to improve or depress the yield. It may be argued that the total plant respiration per unit area increases more than the gross photosynthesis after a certain density and, therefore, there is a decline in the net production. Further increase in the density produces the 'ceiling effect' because of which a dynamic equilibrium is established and hence the production on area basis is not much affected.

## Summary

The influence of population density on morphological features and the dry matter yield of *C. tora*, an annual plant of gregarious habit, has been examined. It has been observed that:

(1) Increase in the population density beyond a certain value results in the decline of stem diameter, number of branches, lateral spread of shoots and roots, and dry matter yield.

(2) Increase in population density increases plant height.

(3) Net production of dry matter is far greater than the nearby perennial grassland communities.

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