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# Comparative Growth Analysis of Parthenium and Other Weeds in Sorghum Ecosystem

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## ABSTRACT

Parthenium (*Parthenium hysterophorus* L.) is a new encroacher weed into many crops including sorghum. An attempt was made to analyse the growth of parthenium and other weeds in sorghum. In sorghum, *Trianthema portulacastrum*, *Acrachne racemosa*, *Dactyloctenium aegyptium*, *Digera arvensis* and *Tribulus terrestris* exhibited much higher population and dry weight than parthenium. Parthenium had inferior growth in terms of population and dry weight at 30, 60 and 90 DAS compared to most other weeds. But its weed growth rate (WGR) and weed relative growth rate (WRGR) were on the increase consistently till 90 DAS. The reverse was true for other weeds, whose growth rates (WGR and WRGR) decreased gradually over time.

**Key words :** Parthenium, sorghum, weed, weed growth rate



## INTRODUCTION

Weeds are ubiquitous and have a wide range of ecological amplitude. They are in a continual state of change in the agro-ecosystem. Weed dynamics in the forms of occurrence, predominance or disappearance of certain weeds or a class of weeds from a crop, cropping system or area/locality. Appearance of more vigorous forms of weeds like perennial weeds, resistant weeds, and invasion/encroachment of new weeds, has occurred in the past and continues to occur (Das, 2001). Weed encroachment into a new habitat is a continuous natural phenomenon duly affected by man, animals, wind and other biotic and abiotic factors. Encroachment of a plant species begins unknowingly/unsightly to humans, but is realized when the very plant species establishes itself with huge plant population and soil seed bank. Crop fields are highly vulnerable to invasion by weeds, which quickly dominate unless properly cared for (Maheshwari, 1990). A case in point is *Parthenium hysterophorus* L. (Parthenium; sub-tribe Ambrosiinae; tribe Heliantheae; family Asteraceae) an annual, herbaceous, highly naturalized and poisonous weed (Mahadevappa, 1997; Besufekad *et al*., 2005). Having originated in tropical North (Mexico, USA) and South America and West Indies, it has spread like a wild fire in tropical countries of the world including India (Aneja *et al*., 1991). In the initial years, it used to grow in the undisturbed wastelands/non-cropped areas, and not in the crop fields (Mahadevappa, 1997). It was believed to be a stray weed, which could not withstand close competition in crop field. However, it has gradually encroached into agricultural lands with huge population in a number of crops including sorghum (Mahadevappa, 1997; Das, 2002; Besufekad *et al*., 2005). An attempt has, therefore, been made to compare the growth of parthenium and other weeds in sorghum.

## MATERIALS AND METHODS

The study was undertaken during rainy season (June-November) of 2000 at the Division of Agronomy, Indian Agricultural Research Institute, New Delhi. Data were collected from a grain sorghum (variety CSH 14) field, which was naturally infested with weeds including parthenium. Parthenium had been occurring in this field for last few years. The soil was well-drained, sandy-loam in texture, non-saline and slightly alkaline (pH 8.0) with 0.56% organic C, 266.4 kg/ha available N, 18.9 kg/ha available P and 202.5 kg/ha available K.

Three plots were demarcated in a sorghum field having natural infestation of weeds including parthenium. The gross plot size was 5.0 x 3.0 m. Parthenium and other weeds were counted individually from two locations in each plot using a quadrat (0.5 x 0.5 m) at 30, 60 and 90 days after sowing (DAS). Weed species were collected, sun-dried for two days, and then kept in an electric oven at $70^0$C for 48 h for estimating their dry

weights. Weed growth rate (WGR) and weed relative growth rate (WRGR) of the weed species were calculated as per Radford (1967).

## RESULTS AND DISCUSSION

### Weed Population and Dry Weight

Species-wise composition revealed that nine weeds including parthenium were associated with sorghum (Tables 1, 2 and 3). *Acrachne racemosa* (Roem. & Schult.) Ohwi., *Dactyloctenium aegyptium* (L.) P. Beauv. Willd., *Commelina benghalensis* L. and *Cyperus rotundus* L. were monocot weeds, whereas *Trianthema portulacastrum* L., *Tribulus terrestris* L., *Digera arvensis* L., *Convolvulus arvensis* L. and *Parthenium hysterophorus* L. were dicot weeds. Dicot weeds were more than monocot weeds *albeit* the density and dry weight of an individual weed recorded a great variation. Hazra (2001) reported similar weeds distribution in the experimental area during rainy season. *A. racemosa* at 30 DAS and *D. aegyptium* at 60 and 90 DAS were relatively dominant because of longer growing duration (Tables 1 and 2). *D. aegyptium* and *C. benghalensis* emerged later than 30 DAS. *C. arvensis* was not observed at 90 DAS. This is often observed in agro-ecosystems (Das, 2001), and is mainly due to weed dynamics in the forms of periodicity of germination, emigration or immigration of weeds occurring in crops (Das, 2008).

Density and dry weights of all weeds were 884, 268 and 171 plants/m$^2$ (Table 1) and 204.3, 360.3 and 438.4 g/m$^2$ (Table 2), respectively, at 30, 60 and 90 DAS. Parthenium shared only 1.2, 2.2 and 4.7% of the total weed density and 1.1, 1.1 and 2.1% of the total weed dry weight, respectively, at these dates. This clearly indicated that the growth of parthenium was inferior to that of most other weeds across the growth stages, although majority weeds including parthenium emerged



Table 1. Density of weeds associated with sorghum at different days after seeding (DAS)

| Weed species | Density (No./m$^2$) | | | Total weed density (%) | | |
|---|---|---|---|---|---|---|
| | 30 DAS | 60 DAS | 90 DAS | 30 DAS | 60 DAS | 90 DAS |
| *Parthenium hysterophorus* | 11 | 6 | 8 | 1.2 | 2.2 | 4.7 |
| *Acrachne racemosa* | 479 | 65 | 34 | 54.2 | 24.3 | 19.9 |
| *Trianthema portulacastrum* | 328 | 39 | 20 | 37.1 | 14.6 | 11.7 |
| *Dactyloctenium aegyptium* | - | 111 | 71 | - | 41.4 | 41.5 |
| *Tribulus terrestris* | 27 | 6 | 12 | 3.1 | 2.2 | 7.0 |
| *Cyperus rotundus* | 26 | 14 | 5 | 2.9 | 5.2 | 2.9 |
| *Digera arvensis* | 7 | 17 | 16 | 0.8 | 6.3 | 9.4 |
| *Convolvulus arvensis* | 6 | 4 | - | 0.7 | 1.5 | - |
| *Commelina benghalensis* | - | 6 | 5 | - | 2.2 | 2.9 |
| Total | 884 | 268 | 171 | 100 | 100 | 100 |

Table 2. Dry weight of weeds associated with sorghum at different days after seeding (DAS)

| Weed species | Dry weight (g/m$^2$) | | | Total weed dry weight (%) | | |
|---|---|---|---|---|---|---|
| | 30 DAS | 60 DAS | 90 DAS | 30 DAS | 60 DAS | 90 DAS |
| *Parthenium hysterophorus* | 2.2 | 4.1 | 9.2 | 1.1 | 1.1 | 2.1 |
| *Acrachne racemosa* | 85.1 | 95.7 | 97.6 | 41.7 | 26.6 | 22.3 |
| *Trianthema portulacastrum* | 88.8 | 127.0 | 132.2 | 43.5 | 35.2 | 30.2 |
| *Dactyloctenium aegyptium* | - | 83.7 | 127.7 | - | 23.2 | 29.1 |
| *Tribulus terrestris* | 6.3 | 12.8 | 22.5 | 3.1 | 3.6 | 5.1 |
| *Cyperus rotundus* | 3.3 | 4.9 | 5 | 1.6 | 1.4 | 1.1 |
| *Digera arvensis* | 16.5 | 24.6 | 31 | 8.1 | 6.8 | 7.1 |
| *Convolvulus arvensis* | 2.1 | 3.2 | - | 1.0 | 0.9 | - |
| *Commelina benghalensis* | - | 4.3 | 13.2 | - | 1.2 | 3.0 |
| Total | 204.3 | 360.3 | 438.4 | 100 | 100 | 100 |

Table 3. Growth rate (WGR) and relative growth rate (WRGR) of weeds associated with sorghum at different stages

| Weed species | WGR (g/m²/day) | | | WRGR (g/g/day) | | |
|---|---|---|---|---|---|---|
| | 30 DAS | 60 DAS | 90 DAS | 30 DAS | 60 DAS | 90 DAS |
| *Parthenium hysterophorus* | 0.07 | 0.05 | 0.15 | 0.009 | 0.021 | 0.037 |
| *Trianthema portulacastrum* | 2.96 | 1.26 | 0.15 | 0.152 | 0.014 | 0.002 |
| *Acrachne racemosa* | 2.83 | 0.34 | 0.04 | 0.150 | 0.006 | 0.001 |
| *Dactyloctenium aegyptium* | - | 2.74 | 1.44 | - | 0.149 | 0.015 |
| *Digera arvensis* | 0.55 | 0.26 | 0.19 | 0.094 | 0.015 | 0.008 |
| *Tribulus terrestris* | 0.21 | 0.20 | 0.30 | 0.058 | 0.026 | 0.021 |
| *Cyperus rotundus* | 0.11 | 0.04 | -0.02 | 0.031 | 0.010 | -0.011 |
| *Convolvulus arvensis* | 0.07 | 0.02 | - | 0.006 | 0.005 | - |
| *Commelina benghalensis* | - | 0.10 | 0.27 | - | 0.030 | 0.051 |

simultaneously. *T. portulacastrum*, *A. racemosa*, *D. aegyptium*, *D. arvensis* and *T. terrestris* exhibited higher density (Table 1) and accumulated higher dry weight than parthenium (Table 2). *C. rotundus* had lower dry weight, but its density was comparable with these weeds. These weeds are mostly recurrent annuals and naturalized over long time in an over-crowded condition in sorghum field micro-climate. On the contrary, parthenium due to recent encroachment (Das, 2002), could not fully tolerate initial over-crowding of weeds particularly of *T. portulacastrum* and *A. racemosa*. Dry matter production *of T. portulacastrum* was higher than weeds at all the growth stages (Table 2). Hazra (2001) reported similar dominance of this weed in soybean. Due to vigorous and rapid growth, *T. portulacastrum* forms a carpet over the soil surface, and smothers other plants growing in the vicinity. It smothered parthenium and, to some extent, other weeds too in this study. Parthenium recorded higher dry weight at 90 DAS (Table 2), due to continued and consistent growth by virtue of its photo- and thermo-insensitivity (Navie *et al*., 1996; Mahadevappa, 1997). Besides, fast-growing annual weeds, particularly *T. portulacastrum* ceased its growth and reached maturity by 60-65 DAS. Thus, natural competition from other weeds was reduced. Kohli and Rani (1994) had similar observations that parthenium germinated and grew well even with delayed onset of rains with one or two light showers at the beginning of season. However, when normal season started with good and adequate rainfall, parthenium became relatively low in proportion to the rest of weed species.

## Growth Rates of Weeds

Parthenium had a fluctuating weed growth rate (WGR) because of its slow and gradual acclimatization in sorghum ecosystem (Table 3). It had higher WGR at 0-30 DAS, which decreased at 30-60 DAS. Its WGR again increased during 60-90 DAS. The WGR, however, was lesser than that of *T. portulacastrum*, *A. racemosa* and *D. aegyptium*. Weed relative growth rate (WRGR) of all weeds except parthenium declined steadily with the advancement of growth stage. Parthenium at the initial stage (during 0-30 DAS) although exhibited lower WRGR compared to those of many other weeds, its WRGR increased in the subsequent 30-60 and 60-90 DAS. This may be due to the tendency of parthenium to become a perennial attaining a height up to 1 m or more (Haseler, 1976). The elongation in height or growth of parthenium continues when most annual weeds reach senescence/maturity. This might have resulted in an increase in the WRGR of parthenium at later stages, while WRGR decreases gradually in most annual plants over time. This explains the fact as to how parthenium takes over slowly the possession of a land eliminating other weeds.

Thus, it may be concluded that parthenium was inferior in terms of density and dry weight to many annual weeds under natural infestation in sorghum. It, however, had consistently increasing growth rate and relative growth rate upto 90 DAS, when all other weeds showed a decreasing trend in growth. This explains how parthenium surpasses other weeds, and slowly encroaches into arable land.

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