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Some Observations on the Root System of some Tropical Dicotyledonous Weeds[1]

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Abstract. Studies were conducted to understand the rooting patterns of some major dicotyledonous weeds, which play an important part in the competition for nutrients, moisture, and space with the crops. Observations indicated that the weeds had wide range of variations in their rooting patterns like depth of tap root, frequency, distribution, and angular diversions of lateral roots at different zones of the tap root. On the basis of the distribution of the lateral roots, the dicotyledonous weeds were grouped under seven major categories. The distribution of lateral roots at different zones indicated their efficiency in competition with the associated crops. It is suggested that the efficacy of a weed control method on a particular weed depends considerably on the pattern and distribution of its root system. The results are interpreted as supporting evidence to the belief that the study of root systems of weeds and the associated crops can be an important field of research in weed ecology and crop-weed association.

INTRODUCTION

The structure of the root system of weeds plays an important role in the efficient uptake of nutrients and moisture from the soil while competing with the growing crops. The depth, frequency and pattern of root system indicate how efficiently a particular weed competes with the growing crop. Knowledge about the root system of particular weed may also enlighten workers about the possible methodology for controlling the weeds having shallow root system, but for widely divergent and deep rooted weed species (e. g. *Convolvulus arvensis*) foliar application of herbicides may not yield good response. By such foliar treatment on deep rooted species only above ground foliage and shoots may be killed without having any effect on underground shoots and roots which may again sprout under favourable conditions.

The weeds with deep profuse lateral root system offer an extra problem in semi-arid tropics where scarcity of water often limits crop production. Those weeds which possess extensive root system can efficiently draw soil moisture from

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the deep soils, thereby extracting the stored moisture in the deep black soils. Crop-weed competition becomes acute in rainfed areas, as weeds utilize the moisture that would otherwise be used by crops. It has been reported that more water is required to raise a ton of weeds than a ton of crops under rainfed farming conditions. This is mainly because of extensive deep root systems of weeds as compared to shallow rooted crops (Kanitkar and Gokhale, 1960).

MATERIALS AND METHODS

During the kharif 1975, we made some preliminary observations on the root system of some important dicotyledonous weeds. The roots were collected from the experimental fields of ICRISAT with the help of a 'shovel' and spade. The length and depth of tap root, maximum extensions and number of lateral roots and their frequency at diffi rent zones were noted. The distribution of secondary lateral roots from the root was classified as follows (Maiti 1977) :

Zone I—Roots distributed at surface zone.

Zone II—Roots at middle half of the tap root or subsoil level.

Zone III—Roots present in deeper soil.

On the basis of the pattern of distribution, the root system of different weeds have been grouped into different classes. Roots of the following weeds were collected and observed during the study :

Amaranthaceae : *Digera arvensis* Forsk ; *Amaranthus spinosus* L. ; *Alternanthera echiata* Sm. ; *Achyranthes aspera* L. : *Celosia argentea* L.

Papavaraceae : *Argemone mexicana* L. Capparidaceae : *Gynandropsis pentaphylla* L. Merr. Tilliaceae : Corchorus olitorius L. ; *Triumfetta rhomboidea* L. Malvaceae. *Abelmoschus* sp. ; *Hibiscus panduraeformis* Burm. ; *Sida cordifolia* L. ; *Sida rhombifolia* L. Euphorbiaceae : *Acalypha indica* L. ; *Croton bonplandianum* Baill, ; *Euphorbia hirta* L. ; *Euphorbia pilulifera* L. ; *Phyllanthus niruri* L. ; Papilionaceae : *Crotalaria incana* Roth. : *Crotalaria spectabilis* L. ; *Lathyrus odoratus* L. ; *Melilotus alba* Lamk. ; *Sesbania aculeata* Pers, ; Caesalpinoideae : *Cassia occidentalis* L. ; *Cassia tora* L., Boraginaceae : *Trichodesma indicum* R. Br. ; Labiatae : *Ocimum sanctum* L. ; *Leucas aspera* Spreng. Solanaceae : *Datura metel* L. ; *Physalis minima* Linn Var. Indica L. ; *Solanum nigrum* L. ; Pedaliaceae : *Martynia diandra* Glox. Acanthaceae : *Asteracantha longifolia* (L.) Nees. Rubiaceae : *Oldenlandia paniculata* L. ; Compositae : *Ageratum conyzoides* L. ; *Acanthospermum hispidum* DC. *Blumea bifoliata* DC. ; *Eclipta alba* Hassk. ; *Flavaria australasica.* ; *Lagascea mollis* Cav. ; *Sonchus*

aspera Vill. ; *Tridax Procumbens* Linn. ; *Xanthium strumarium* Linn. ; *Volutarella divaricata* Benth.

RESULTS AND DISCUSSION

The members of the family Amaranthaceae have generally stout and hard tap roots, laterals arising from Zone I and II in acute angles and directing downwards. In *Celosia argentea* stout lateral roots which are profuse at Zone I and II, arise at about right angles. The tap root of *Achyranthes aspera* is mediumly soft. laterals are equally distributed at the three zones. *Digera arvensis* and *Alternathera echiata* have mediumly thick roots with a few slender laterals.

Argemone mexicana (Papavaraceae) has stout tuberous roots growing vertically downwards with the presence of scanty lateral roots. *Gynandropsis pentaphylla* (Capparidaceae) produces a tuberous fleshy tap root with a few stout laterals, mainly at Zone II at acute angles.

Corchorus olitorius and *Triumfetta rhomboidea* (Tiliaceae) produce a long; stout and hard tap root and mediumly profuse lateral roots equally distributed in the three zones at acute angles to the tap root. Divergence of lateral roots are wavy and mediumly hard.

Abelmoschus sp. and *Hibiscus panduraeformis* (Malvaceae) are characterized by stout tap roots and profuse thicker secondary laterals more or less equally distributed at three zones and arising at right angles near Zone I. Lateral divergence of secondary laterals is broad but in *Sida* the tap root is relatively thinner and wavy with fewer secondary laterals, mainly at Zone II. It is very difficult to eradicate these weeds by hand pulling because the undergr(und basal shoot often sends new growth (especially *Sida*).

The members of Euphorbiaceae have a slender wiry tap root system with a few lateral more or less equally distributed at the three zones arising from the tap root at acute angles (e. g. *Euphorbia hirta*, *Euphorbia pilulifera*, *Acalypha indica*). *Phyllanthus niruri* and *Croton sparciflorus* have woody tap root systems.

The tap root of the members of Papilionaceae are of two types :—(1) Stout root—*Sesbania*, *Crotalaria*, and (2) Thin root—*Lathyrus odorotus*. The tap roots are generally soft and hollow with mediumly stout laterals arising from Zone I passing obliquely downwards reaching to Zone II and exceeding the length of the tap root. *Sesbania aculeata* have more or less fibrous lateral roots mainly at Zone I, arising from a fleshy, soft and hollow tap root. *Lathyrus odoratus* and *Melilotus alba*

have slender, somewhat wiry tap roots with a few wiry lateral roots. *Crotalaria spectabilis* have very long and thin tap roots with a few stout lateral roots arising from Zone I and passing downwards in a wavy pattern, exceeding the length of the tap root towards the deeper zone. Eradication of Papilionaceous weeds is relatively easy by pulling out the plant and there is less chance of regrowth of new plants from the remaining underground portion.

Cassia occidentalis (Caesalpinoideae) are characterised by stout, hard and hollow curved tap roots and a few stout lateral roots, arising mainly from Zone II at a higher acute angle or at right angles and diverging downwards in a zig-zag way. Because the tap root is very hard, it is very difficult to eradicate the *Caesalpinoidaeous* weeds by hand pulling and there is great chance for regrowth from underground shoot and root.

Trichodesma (Boraginaceae) produces wavy and hollow tap roots with scanty secondary laterals.

Lantana camara (Verbenaceae) has a vertically directed mediumly thin root with a few secondary laterals at Zone I and II.

Ocimum sanctum (Labiatae) has a more or less quadriangular and curved tap root with a few lateral roots. *Leucas aspera* has also a similar type of curved tap root with mediumly profuse lateral roots arising at acute angles, mainly from Zone I and II, growing obliquenly downwards. Lateral divergence is mediumly broad.

Datura metel (Solananceae) produces a stout mediumly bent tuberous tap root with a few secondary laterals at Zone II. *Solanum nigrum* produces a more or less similar type of root but with stout, widely diverging lateral roots arising at acute angles, mainly from Zone I and a few from Zone II. *Physalis minima* has a stout root with the network of fibrous roots restricted at Zone I.

Martynia diander (Pedaliaceae) produces a very hard and stout tap root growing vertically downwards and mediumly profuse, stout secondary laterals distributed more or less equally at three zones. The laterals form acute angles and grow obliquely to deeper levels.

Asteracantha longifolia (Acanthaceae) has a stout tuberous root and widely diverging laterals arising at Zone I. *Oldenlandia corymbosa* (Rubiaceae) has a slender and somewhat wavy wiry tap root with a few secondary laterals arising at acute angles from Zone I and II.

Ageratum conyzoides (Compositae) has a mediumly thick tap root with profuse secondary laterals arising at Zone I and growing obliquely downwards. *Acanthospermum hispidum, Tridax procumbens, Flavaria* sp. have a slender somewhat wavy tap root with mediumly profuse secondary laterals distributed more or less equally at Zone I and II and some at Zone III.

Based on above observations the root systems of these different dicotyledonous weeds can be grouped in the following different classes :

1. Deeply penetrating stout tap root with scanty secondary laterals :— *Cassia tora, C. occidentalis, Crotalaria incana, C. spectabilis, Ricinus communis, Croton, Lantana, Martynia* and *Datura.* These weeds are expected to be more efficient in removing moisture from deeper soil. The stubbles of their deep root may offer resistance while ploughing, especially with the country plough (Figs. 1-9).

2. Less deeply penetrating slender tap root with superficial groups of lateral roots and scanty laterals at lower levels :—*Psoralea, Phyllanthus, Oldenlandia* and *Trichodesma.* These weeds remove moisture and nutrients from the surface soil and are not harmful in offering resistance (Figs. 10-12).

3. Tuberous tap root, broad at the top and gradually narrow downwards, with scanty secondary laterals :—*Argemone mexicana, Sonchus* and *Gynandropsis.* These species offer competition for the moisture and nutrients present in the surface soil. Since they possess stout and broad tap roots, they offer serious competition to the shallow rooted crops (Figs. 13).

4. Moderately stout tap root (which may be branched) with prominent thick lateral roots obliquely pointing downwards and equally distributed at the three zones : *Digera arvensis, Amaranthus spinosus, Alternanthera sessillis, Achyranthes aspera, Sesbania, Abelmoschus, Hibiscus, Corchorus* and *Xanthium.* These are more efficient than the class three weeds since they also possess lateral roots which enable them to draw moisture and nutrients from sideways (Figs. 14-18).

5. Moderately slender, curved tap root with mediumly profuse secondary laterals, equally distributed at three zones and directing downwards at an acute angle : *Lathyrus* sp. *Melilotus, Phyllanthus, Acalypha, Euphorbia, Sida, Triumfetta, Leucas, Acanthospermum, Tridax* and *Ocimum* The lateral roots play the major role in moisture and nutrient uptake (Figs. 19-24).

6. Short tap root with groups of fleshy lateral roots at the upper part of the root and scanty laterals at lower levels :—Eg. *Asteracantha longifolia.* In these

PLATE: 1

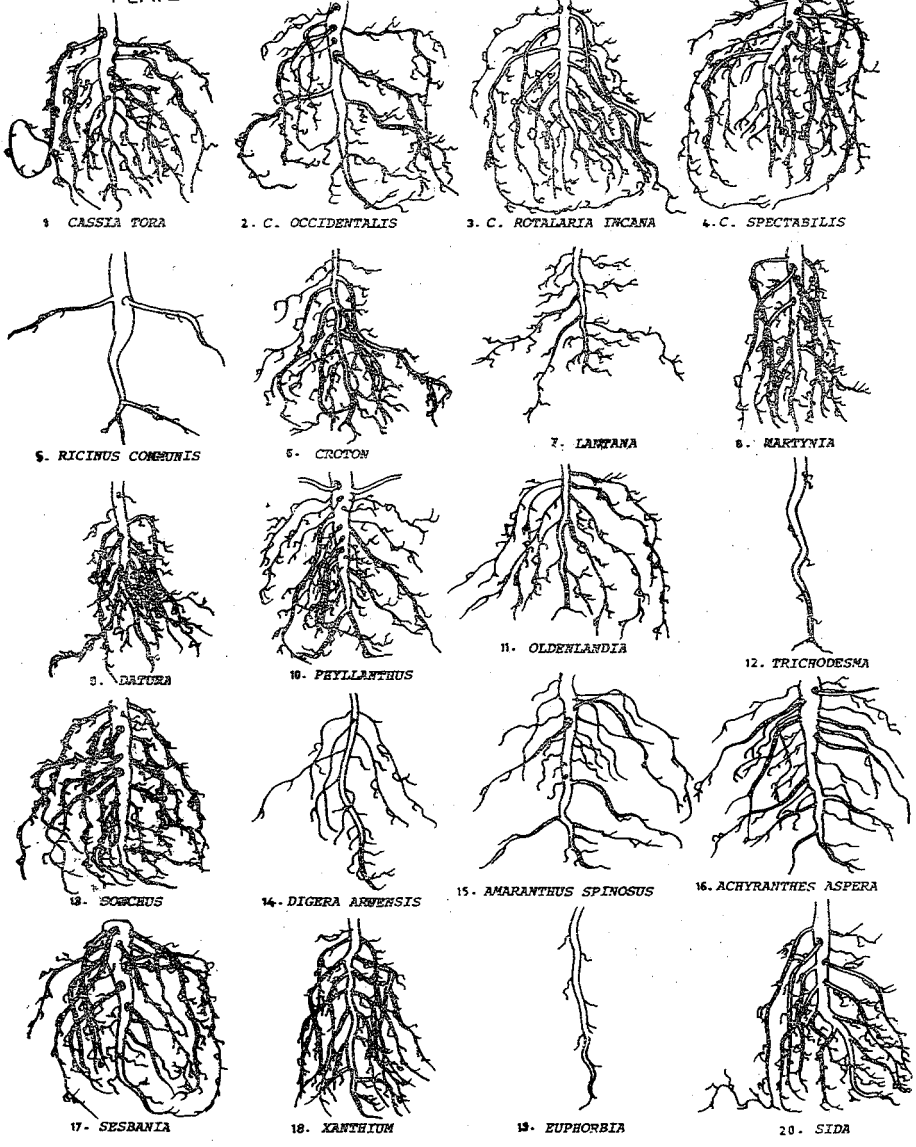
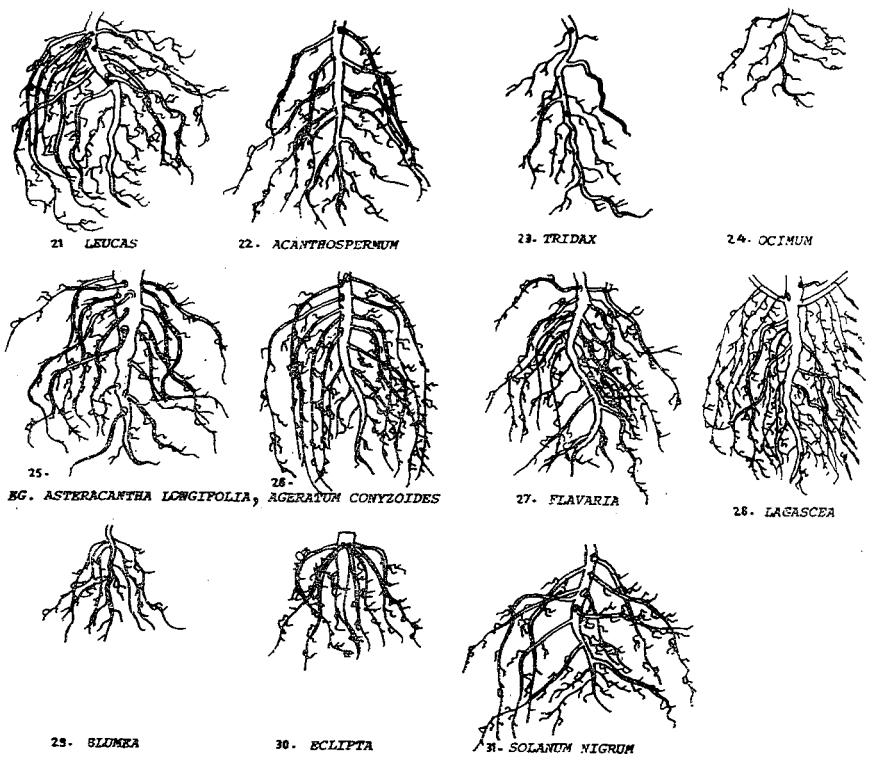

1. CASSIA TORA
2. C. OCCIDENTALIS
3. C. ROTALARIA INCANA
4. C. SPECTABILIS
5. RICINUS COMMUNIS
6. CROTON
7. LANTANA
8. MARTYNIA
9. DATURA
10. PHYLLANTHUS
11. OLDENLANDIA
12. TRICHODESMA
13. SORGHUS
14. DIGERA ARVENSIS
15. AMARANTHUS SPINOSUS
16. ACHYRANTHES ASPERA
17. SESBANIA
18. XANTHIUM
19. EUPHORBIA
20. SIDA

PLATE 2



weeds the fleshy lateral roots absorb moisture and nutrients mainly from surface soil (Fig. 25).

7. Mediumly stout tap root or branched stout root at the base of the stem, diverging more or less in horizontal directions with their fibrous root restricted at Zone 1 :—*Ageratum conyzoides*, *Flavaria*, *Legascea*, *Blumea*, *Eclipta* and *Solanum nigrum*. These weeds seem to be the most efficient in competition for moisture and nutrients. In addition to possessing a fairly deep tap root, they possess numerous laterals in all directions. Therefore, they can take up the nutrients and moisture from all directions, deep from the soil through the tap root and around the crop through the extensive lateral roots. Their root structure resembles that of a monocot fibrous root system. Since compositae plants are highly competitive this family is considered the most advanced of the weed families (Figs. 26-31).

The present study indicates that there is a wide range of variability in the rooting patterns of the weeds studied. They vary widely in the morphology intensity and distribution of lateral roots at different soil zones. These lateral roots play a vital role in the uptake of moisture and nutrients from the respective zones. The weeds having profused lateral roots at different zones of the soil are expected to be of exhaustive nature and hence more competitive with the crop. In this study, we have attempted only to understand the distribution of the root system at different zones of the soil. We have not studied how the root system of these weeds interact with the normal growth of crop roots. Therefore, it is intended to continue these studies on the rooting patterns of both the weeds and the associated crops at different stages of the growth in the crop fields *in situ*. It is anticipated that this investigation may give some clues to the understanding of the competitive nature of the weed roots against the normal growth and function of the crop roots. We also plan to extend our rooting pattern studies to different edaphoclimatic conditions of the semi-arid tropics. We hope that this type of study will suggest new areas of research in the field of weed science.

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