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Influence of Soil Series and Physico-chemical Properties on Weed Flora Distribution at Moor Plantation Ibadan, Southwestern Nigeria

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ABSTRACT

Influence of soil series and some soil physico-chemical properties on weed flora composition, density and distribution were assessed. The main objective was to find relationship between soil series and the distribution of different weed species as well as identify those soil properties, which significantly influence the occurrences of specific weed species. Using a detailed soil map (1:10,000), weeds and soil samples were drawn from five soil mapping units – Apomu series, Mamu series, Ibadan series, Iregun series and Iwo series each covering 1.5 ha of the land. From the result of field study occurrences and distribution of different weed species were associated more or less with some soil series than others. Chi-square test of associations showed a high and significant association (χ^2 = 28-88, P = 0.01- 0.001), between soil series and weed occurrence. A stepwise multiple regression analysis (P < 0.05) showed that the soil property for most of the variation in the distribution of some of the major weed species included Mn, which accounted for 80% and 78% in the distribution of *Digitaria horizontalis* and *Euphorbia heterophylla,* respectively. Clay content contributed 68% to the distribution of *Mariscus spp.* and N contributed 59% to the variation in the distribution of *Panicum maximum.* Results showed that in the landscape of Ibadan, certain weed species were associated more with specific soil series. Also the occurrence of some weed species was influenced by specific soil physical and chemical properties.

Key Words: Soil series; Soil physico-chemical properties; Weed distribution/composition

INTRODUCTION

Different plants are known to have different requirements. This implies that differences in the distribution and abundance of weed flora, for instance, in the landscape could be an indication of the variation in soil properties. A good knowledge of the soil properties and their relationships with weeds distribution is said to be highly essential for integrated weed management programs (Akobundu, 1993). Weeds are important components of our Agricultural Farming Systems and their removal is indeed an interference with the natural ecosystem. Therefore, identification of weed control measures that will not contribute to soil degradation or adversely affect environmental quality is important. To achieve this, the nature and extent of interrelationships between soil series, characteristics and weed species occurring within a particular environment need to be understood.

Understanding the relationship between certain soil properties and specific weed species could act as a guide to the farmer to understand the likely soil conditions that could be suitable for a particular purpose. Such knowledge may also aid in mineral prospecting (Veeranjaneyulu & Dhanaraju, 1990). Individual species or groups of plants have been known to act as indicators of ore deposits with certain plants occurring exclusively on metal-rich soils, such as zinc and copper contaminated soils. It may also be possible to identify certain weed species having the potential ability to actively remove certain undesirable substances, which are toxic in the soil system. Such substances include excess salts in soils with salinity problem. In Nigeria, much work has been done on weed management with emphasis on herbicide-soil interactions, while neglecting soil-weed ecology. With this background, a study was carried out to determine the degree of association between soil series and weed species and the extent to which a particular soil property can influence the composition and distribution of specific weed species in agricultural lands at Moor Plantation, Ibadan, southwestern Nigeria.

MATERIALS AND METHODS

Study site. The site for this study was the National Cereal Research Institute (NCRI), Moor Plantation, Ibadan. It lies between latitudes 7^o22^1 N and 7^o24^1 N and longitudes 4^o50^1 E and 4^o51^1 E and approximately 175 m above mean sea level. Mean annual temperature is about 27.3°C and the annual precipitation is 1509 mm.

Weed and soil sampling. This study was carried out when most of the farmlands were left under fallow for about two

years, and covered with weeds. Using the soil map of the farm, weed samples were drawn from five soil series viz: Apomu, Ibadan, Iregun, Iwo and Mamu. The generalized profile description for these series was documented by Smyth and Montgomery (1962).

Each of the five soil series was assigned five sampling units at random. Each sampling unit covered an area of 5 m^2. Using a quadrat (0.75 x 0.75 m in size), weed identification, occurrence/frequency of occurrence within the sampling unit, density and percentage, distribution were determined for each sampling unit. Weed population refers to the total number of weeds per given area, while frequency refers to the number of quadrat throws in which a particular weed was found within the quadrat, irrespective of its population. Density was determined as the number of weeds per square meter and percentage distribution was frequency divided by the total number of quadrat throws. Each sampling unit received five 'quadrat throws', giving 25 'throws' for each soil series. For each quadrat throw, after weed sampling, composite soil sample made of five sub-samples was taken from each sampling unit for laboratory analysis. Identification of the weed species was done by a Weed Science Staff of I.I.T.A., Ibadan, Nigeria.

Laboratory procedures. Soil samples were air-dried and sieved to pass through a 2 mm sieve. They were then analysed as follows: particle size analysis - by Bouyoucus (1962) hydrometer method; organic carbon - by Walkley and Black (1934) (acid dichromate) method; total Nitrogen by Kjeldahl digestion and distillation method (Jackson, 1965), available P by Bray No.1 (Bray & Kurtz, 1945), exchangeable bases by extraction using 1 m ammonium acetate at pH 7; Ca, K and Na by flame photometery and Mg by atomic absorption spectrophotometer. Micronutrients were first extracted with 0.I N HCl and the values determined by atomic absorption spectrophotometery; exchangeable acidity by extraction using I N KCl and titration with 0.1 N NaOH. Effective cation exchange capacity (ECEC) was by summation of exchangeable bases and acidity; electrical conductivity and pH in water (1:2) and KCl (1:2) was read from a pH meter.

Statistical analysis. The chi-square (χ^2) statistic was used to test the association between major weed species and soil series and stepwise multiple regression analysis. Forward selection procedure was used to determine the relative contributions of soil physico-chemical properties to the variation in the composition/distribution of major weed species in the landscape.

RESULTS AND DISCUSSION

Weed flora composition, density and distribution within and among soil series. A total of 33 dominant weed species were identified with 13 (39%), 6 (18%), 4 (12%), 4 (12%), 3 (9%), 1 (3%), 1 (3%) and 1 (3%) from Poaceae, Asteraceae, Euphorbiaceae, Fabaceae, Cyperaceae, Commelinaceae, Nyctaginaceae and Sterculiacae families (Table I). Results showed that among the families, Poaceae was dominant, followed by Asteraceae, while Commelinaceae, Nyctaginaceae and Sterculiaceae families were the least. Broadleaf weeds were the major weed type (16), followed by grasses (13), sedges (3) and spiderwort (1). Sixteen of the weed species had perennial, 16 annual, whereas 1 weed species (*Dactyloctenium aegyptium*) had both annual and perennial life cycles.

Weed species in the study area showed relative selectivity with respect to the soil series in which they occurred as well as their frequency of occurrence within the five sampling units in each soil series (Table I). None of the 33 major weed species identified occurred in all the five soil series and no single soil series contained all the 33 weed species. Ibadan series had the highest weed species occurrence (13 i.e., 39%), followed by Iwo, Iregun and Apomu series with 9 (27%) each, while Mamu series had the lowest occurrence (7 i.e., 21%).

The most widespread of the weeds was *Tridax procumbens,* which occurred in 4 (Iwo, Ibadan, Apomu & Mamu) out of five soil series followed by *Digitaria horizontalis* and *Paspalum scrobiculatum* both of which occurred in Iregun, Iwo and Ibadan series. The highest weed density was observed for *Panicum maximum* (108.1 m^{-2}) in the Iregun series and from *T.* procmbens in Iwo (1584.2 m^{-2}), Ibadan (327.9 m^{-2}), Apomu (52.6 m^{-2}) and Mamu (158.0 m^{-2}) soil series (Table I). The pattern observed for weed density also applied for percent weed distribution.

Chi-square test for association between soil series and weed species occurrence/distribution was highly significant for all weed species (Table II). The following weeds were strictly associated with one soil series: *P. orbiculare, Eragrostis ciliaris, Aspilia africana* and *Cleome retidosperma* (Iregun); *Bracharia vilosa* and *Rhynclelytrum repens* (Iwo); *D. aegyptium, P. conjugatum*, *Cyperus haspan*, *Euphorbia heterophylla*, *Indigofera hirsuta* and *Waltheria indica* (Ibadan); *Andropogon tectorum*, *Imperata cylindrica, C. dilatatus, Chromolaena odorata, Erigeron floribundus*, *Phyllanthus amarus and Commelina erecta* (Apomu); *Synedrella nodiflora, Ageratum conyzoides, E. hyssopifolia* and *Desmodium tortuosum* (Mamu).

Influence of some soil physico-chemical properties on distribution of some dominant weeds. The result of a step-wise multiple regression analysis ($P < 0.05$) to determine the relative contribution (R^2%) of soil physical and chemical properties to the occurrences of six of the major weed species is shown in Fig. 1. The result shows that for *D. horizontalis*, Mn contributed 80%, Mg contributed 16% and Cu 3% to its occurrence. Also, for the occurrence of *P. maximum*, N contributed 59%; base saturation contributed 38% and soil clay content contributed 3%. Similarly, for the occurrence of *E. heterophylla*, Mn contributed 78%, Ca contributed 18% and organic carbon contributed 4%. For the occurrences of *P. scrobiculatum* and *Mariscus alternifolius*, five soil properties contributed in each case. For *P. scrobiculatum*, Bs contributed 52%, Cu, 19%; EC,

Table I. Weed flora composition, density and distribution of five soil series at Moor plantation Ibadan, South Western Nigeria

S/N	Weed Species	Family	Type	Life Cycle	Occurrence/frequency					Weed Density (Number m^{-2})					Weed Distribution (%)				
					Ir	Iw	Ib	Ap	Ma	Ir	Iw	Ib	Ap	Ma	Ir	Iwo	Ib	Ap	Ma
1	*Panicum maximum*	Poaceae	G	P	+(5)	-	-	-	+(1)	108	-	-	-	8	100	-	-	-	20
2.	*Digitaria horizontalis*	Poaceae	G	A	+(5)	+(5)	+(1)	-	-	43	71	11	-	-	32	64	12	-	-
3.	*Paspalum orbiculare*	Poaceae	G	P	+(1)	-	-	-	-	16	-	-	-	-	80	-	-	-	-
4.	*P. scrobiculatum*	Poaceae	G	P	+(3)	+(2)	+(5)	-	-	40	35	50	-	-	16	32	8	-	-
5.	*Eragrostis cilirais*	Poaceae	G	A	+(1)	-	-	-	-	173	-	-	-	-	8	-	-	-	-
6.	*Bracharia vilosa*	Poaceae	G	A	-	+(4)	-	-	-	17	-	-	-	-	-	56	-	-	-
7.	*Rhynchelytrum repens*	Poaceae	G	A	-	+(1)	-	-	-	-	17	-	-	-	-	8	-	-	-
8.	*Sporobolus pyramidalis*	Poaceae	G	P	-	+(1)	-	+(1)	-	-	15	-	18	-	-	4	-	4	-
9.	*Andropogon tectorum*	Poaceae	G	P	-	-	-	+(1)	-	-	-	-	6	-	-	-	-	4	-
10.	*Imperata cylindrica*	Poaceae	G	P	-	-	-	+(4)	-	-	-	-	42	-	-	-	-	68	-
11.	*Dactyloctenium aegyptium*	Poaceae	G	A/P	-	-	+(3)	-	-	-	-	207	-	-	-	-	36	-	-
12.	*P. conjugatum*	Poaceae	G	P	-	-	+(1)	-	-	-	-	10	-	-	-	-	16	-	-
13.	*Andropogon gayanus*	Poaceae	G	P	-	-	+(1)	-	+(1)	-	-	5	-	4	-	-	16	-	12
14.	*Mariscus alternifolius*	Cyperaceae	S	P	+(5)	+(4)	-	-	-	37	30	-	-	-	80	44	-	-	-
15.	*Cyperus dilatatus*	Cyperaceae	S	P	-	-	-	+(1)	-	-	-	-	2	-	-	-	-	4	-
16.	*C. haspan*	Cyperaceae	S	P	-	-	+(1)	-	-	-	-	14	-	-	-	-	4	-	-
17.	*Tridax procumbens*	Asteraceae	B	A	-	+(5)	+(5)	+(4)	+(5)	-	584	328	53	158	-	96	90	76	92
18.	*Aspilia africana*	Asteraceae	B	P	+(1)	-	-	-	-	5	-	-	-	-	4	-	-	-	-
19.	*Chromolaena odorata*	Asteraceae	B	P	-	-	-	+(3)	-	-	-	-	9	-	-	-	-	5	-
20.	*Erigeron floribundus*	Asteraceae	B	A	-	-	-	+(1)	-	-	-	-	19	-	-	-	-	4	-
21.	*Synedrella nodiflora*	Asteraceae	B	A	-	-	-	-	+(1)	-	-	-	-	10	-	-	-	-	12
22.	*Ageratum conyzoides*	Asteraceae	B	A	-	-	-	-	+(1)	-	-	-	-	18	-	-	-	-	4
23.	*Euphorbia hirta*	Euphorbiaceae	B	A	-	+(4)	+(1)	-	-	-	26	1	-	-	-	24	4		
24.	*E. heterophylla*	Euphorbiaceae	B	A	-	-	+(1)	-	-	-	-	4	-	-	-	-	16	-	-
25.	*Phyllantus amarus*	Euphorbiaceae	B	A	-	-	-	+(1)	-	-	-	-	9	-	-	-	-	4	-
26.	*E. hyssopifolia*	Euphorbiaceae	B	A	-	-	-	-	+(1)	-	-	-	-	10	-	-	-	-	16
27.	*Commelina erecta*	Commelinaceae	Sp	P	-	-	-	+(2)	-	-	-	-	10	-	-	-	-	20	4
28.	*Indigofera hirsuta*	Fabaceae	B	A	-	-	+(2)	-	-	-	-	3.5	-	-	-	-	28	-	-
29.	*Calapogonium mucunoides*	Fabaceae	B	A	+(1)	-	+(1)	-	-	0	-	1	-	-	4	-	4	-	-
30.	*Desmodium tortuossum*	Fabaceae	B	A	-	-	-	-	+(1)	-	-	-	-	5	-	-	-	-	-
31.	*Cleome rutidosperma*	Fahaceae	B	A	+(1)	-	-	-	-	3	-	-	-	-	4	-	-	-	-
32.	*Boerhavia erecta*	Nyctaginaceae	B	P	-	+(2)	+(1)	-	-	-	13	16	-	-	-	8	4	-	-
33.	*Waltheria indica*	Sterculiaceae	B	P	-	-	+(1)	-	-	-	-	1.4	-	-	-	-	4	-	-

N/B: Values are means from 5 sampling units within each soils series.
P = Perennial, A = Annual; G = Grass, B = Broadleaf, S = Sedge, Sp = Spiderwort
+ Presence, - Absence. Values in pararenthesis indicate frequency of weed species occurrences, within each soil series.
Ir = Iregum, Iw = Iwo, Ib = Ibadan, Ap = Apumo, Ma = Mamu

14%; Zn, 9% and Fe, 5% to its occurrence. For *Mariscus* spp, C contributed 68%, ECEC, 16%; organic carbon, 8%; silt content, 6% and K, 2%.

Compared to the above five weed species, the occurrence of *T. procumbens* was found to be influenced by relatively large number (up to 12) of the 21 soil properties, with no single property playing a dominant role in the occurrence of this weed in the landscape (Fig. 1). The highest partial contribution of 16% was made by fine sand fraction, closely followed by K, 15%; ECEC, 13% and Bs, 12%, while the remaining eight properties jointly contributed 43%. The implication of this observation is that unlike the other five weed species, *T. procumbens* was not highly specialized in its substrate requirement. Hence it had the greatest potential of growing on wide range of soil conditions, being the most common weed observed in the study area, occurring in four of the five soil series.

Table II. Chi-square (χ^2) test results showing association between soil series and weed species occurrence/distribution at Moor Plantation, Ibadan, Nigeria

Soil series	Df	χ^2	Significance
Iregun	12	28.96	**
Iwo	20	48.07	***
Ibadan	32	88.33	***
Apomu	12	28.76	* *
Mamu	28	74.73	* * *

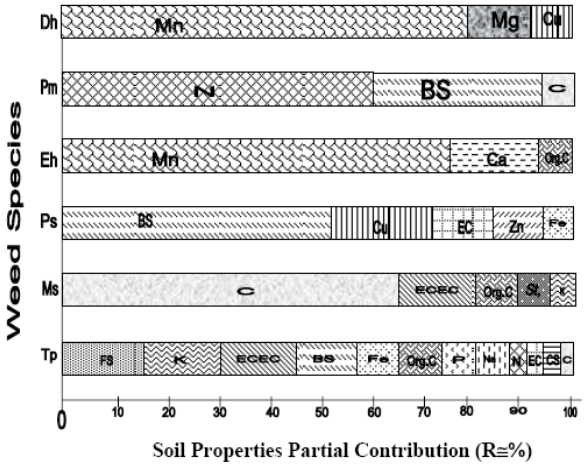
** = P $\leq$ 0.01 ; *** = P $\leq$ 0.001

The influences of soil types and soil properties on the distribution of certain plant species in the landscape have earlier been observed by other workers. Woo *et al.* (1991), Malik and Born (1988) and Frick (1984), in their various studies observed that weed species distribution was influenced by soil series. Similarly Petry *et al.* (1991) observed the influenced of organic matter, while Andreasen and Streibig (1990) and Sharma (1986) observed the influence of soil texture on weed occurrence. On the other hand, Aarssen *et al*. (1986) observed that five *Vicia* species were not highly specialized in their substrate requirements, although they were generally associated with sandy soils.

CONCLUSIONS

This study has shown that weed species in the landscape of Ibadan, southwestern Nigeria, were relatively selective with respect to the soil series in which they occur. There was a highly and significant (P < 0.01) association between the soil type and weed species distribution in the landscape. Also, certain soil physical and chemical

Fig. 1. Partial contribution (R ≅ %) of soil physical and chemical properties in weed distribution
Dh = Digitaria horizontalis; Eh = Euphorbia heterophylla; Pm = Panicum maximum;Ps = Paspalum scrobiculatum; Ms = Mariscus species; Tp = Tridax procumbens.



properties exert significant influence on the occurrences types and distribution of specific weed species in the landscape. Particularly, the occurrences of *D. horizontalis and E. heterrophylla* are highly controlled by Mn, *P. maximum* was mostly influenced by total N, while the occurrences of *P. scrobiculatum and M. alternifolius* was mostly influenced by base saturation and soil clay content, respectively.

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