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Effect of Soil Type On Growth Of *Cajanus cajan*. var. T-84

I. INTRODUCTION

All plants keep growing as long as they live. Growth is associated with numerous physiological processes, both constructive and destructive. Growth is a complex process which brings about a permanent or irreversible change in plant as a whole or its part with respect of its size, form, weight and volume. Increase in dry weight is one important aspect of growth. In germinating seeds initially there is decrease in dry weight as the stored food material is used in the formation of seedling.

Many astonishing changes occur during the growth of the plant. When a seed grows into a mature plant, it alters remarkably in size and shape. Roots, stems and leaves appear as the organs of the seedling and during maturity, organs concerned with reproduction - the flowers, fruits and seeds - are formed and they grow further.

Growth does not occur haphazardly but is co-ordinated: for instance, the shape of mature leaves is usually constant for a given species, flowers are produced on shoots, not on roots. This co-ordinated nature of growth implies the functioning of extraordinarily precise controls. These controls are sensitive to the environment. Plants are much more affected by their environment than are many animals which develop a more standardised internal environment of their own.

Among the plant environmental factors, soil is the most important one. But unfortunately plant and soil scientists have found little common interest in the study of the growth and function of root systems in the soil (Russell, 1977).

The utility of the plant species to its consumers is queised from its capacity (a) to produce organic matter in the form of dry matter or biomass and/or (b) to reproduce giving grain yield directly available for the consumers. Generally, this capacity is termed as 'productivity'. Productivity of any plant species is a basic vital criterion of growth measurement on which the whole ecosystem is dependent.

In the present investigation attempt has been made to measure the productivity of the plant under study in both ways: in terms of biomass production as well as in terms of grain yield. The study presents the effect of soil type on growth characteristics of C. cajan var. T-84.

II. MATERIAL AND METHODS

a) Material :

The plants of C. cajan var. T-84 raised in the field plots at College campus were used for the study of growth parameters like plant height, shoot length, root length, shoot/root ratio leaf-area, number of branches, branching angle etc.

After harvesting the plants the yield of the plants were estimated. For this purpose number of seeds per pod, number of pods per plant, 100 grain weight and biomass were determined.

b) Methods :

Height of all the plants in each plot was measured in cms and from these readings average height of the plant was obtained. From each field plot thirty plants were selected randomly for shoot measurement. The height was measured from the ground surface upto the stem tip. Average shoot length was determined from all readings. For the measurement of root system the same thirty plants were dug out along with the root system and root length was measured. Average root length was calculated from all readings. From the above readings shoot/root ratio was calculated. Thirty leaves of the plants from each field plot were selected randomly for the measurement of leaf area. Planimeter was used for this purpose. Average leaf-area of a single leaf was determined from all readings. Average number of branches per plant were determined by counting the total number of branches of all the plants from each field plot. Branching angle was measured by keeping the paper in the background and marking the angle by pencil.

After harvesting the plants the yield was determined. For this purpose number of seeds per pod were counted and

Table 4.1 : Effect of soil type on growth parameters of C.cajan var.T-84

Soil Type	Average shoot length cms.	Average root length cms.	Average total height cms.	Average shoot/root ratio	Average leaf area (single) sq. cms.	Average no. of branches/ plant	Average branching angle (degree)
Red	85.00	13.21	98.21	6.45	11.98	6.9	42.9
S.D.	3.52	0.82	2.17	0.479	2.30	0.48	5.04
Black	107.00	15.23	122.23	7.02	15.44	9.6	50.7
S.D.	5.67	3.55	4.61	1.65	3.91	2.21	3.36
Red + Black	98.00	17.98	115.98	5.45	12.33	9.7	48.9
S.D.	3.84	2.78	3.31	1.32	1.57	0.89	2.09

Table 4.2 : Effect of soil type on growth parameters of <u>C.cajan</u> var.T-84

Soil Type	Average no.of seeds/pod.	Average no.of pods/plant	100 grain wt.	Bomass (Dry matter per plant) g	Measured yield/plant g	Calculated yield/ha. kg.
Red	3.3	44.00	10.25	36.43	14.88	925.86
S.D.	0.82	1.29	1.68	2.72	1.77	9.20
Black	3.5	59.00	11.66	43.12	24.07	1498.12
S.D.	0.92	1.26	1.18	1.37	1.42	4.60
Red + Black	3.4	49.00	10.99	43.52	18.30	1139.22
S.D.	1.30	2.82	1.13	2.36	2.15	1.77
T value significant at 5 % only for Red and Black soils				6.60	12.15	

FIG. 4.1

Photograph showing the difference in growth parameters of C.carian, var. T-84 grown on different types of soils. A) Plant grown in the red soil, B) Plant grown in the red + black soil, C) Plant grown in the black soil.


A
B
C

average number of seeds per pod was calculated. Similarly number of pods per plant was counted and average number was calculated, 100 grain weight was recorded. The weight of dry matter per plant was recorded as biomass. Measured yield per plant was calculated with the help of average number of seeds per pod, average number of pods per plant and 100 grain weight. From this calculated yield per hectare was determined.

III. RESULTS

Table 4.1 and Fig. 4.1 represent the growth characteristics as affected by the soil type. The table records different parameters of growth like, total height of the plant, shoot length and root length, shoot/root ratio, single leaf area, number of branches per plant and the angle of branching (i.e. orientation of branches). All the parameters show highest degree in case of plants growing in the black soil. The shoot length is increased under the black soil conditions however the extent of root system is more in the mixture of the red and the black soil; possibly this combination favours root growth. Inspite of more root growth in the black soil as compared to the red one, shoot/root ratio is more in the black soil.

The leaf area, even if of a single leaf, is the indication of photosynthetic area. It is also increased in the black soil conditions. Not only this but also the number of branches per plant and the angle of branches with the main stem also increase in the black soil.

The data presented in Table 4.1 can be easily correlated with that present in Table 4.2. It clearly shows that the productivity of the crop and the yield is highest in the black soil. Table 4.2 shows that the mixture of the red and the black soil has intermediate productivity and the red soil has least. The biomass in case of the red soil is considerably less whereas in other two types of soils it is almost the same. The comparative graphical representation is given in Fig. 4.2.

IV. DISCUSSION

In the present investigation the average height of plants in the red soil is less while the height of plants in the black soil is maximum. Plants in the red + black soil show intermediate average height. This can be clearly seen from the Fig. 4.1. This can be explained with the help of moisture percentage of the soil. Garwood and Williams (1967) observed in perennial ryegrass (*Lolium perenne*) the growth had ceased before the water potential of the soil was reduced to the low values but rapid growth was resumed within a few weeks of ample water being again provided. In the present investigation the plants in the black soil are taller than the plants in the red and the red + black soil. This might be due to the high water holding capacity of the black soil. As the average total height of the plants in the black soil is more the shoot length is also more.

FIG. 4.1

Effect of soil type on average leaf area, biomass, 100 grain weight and measured yield.

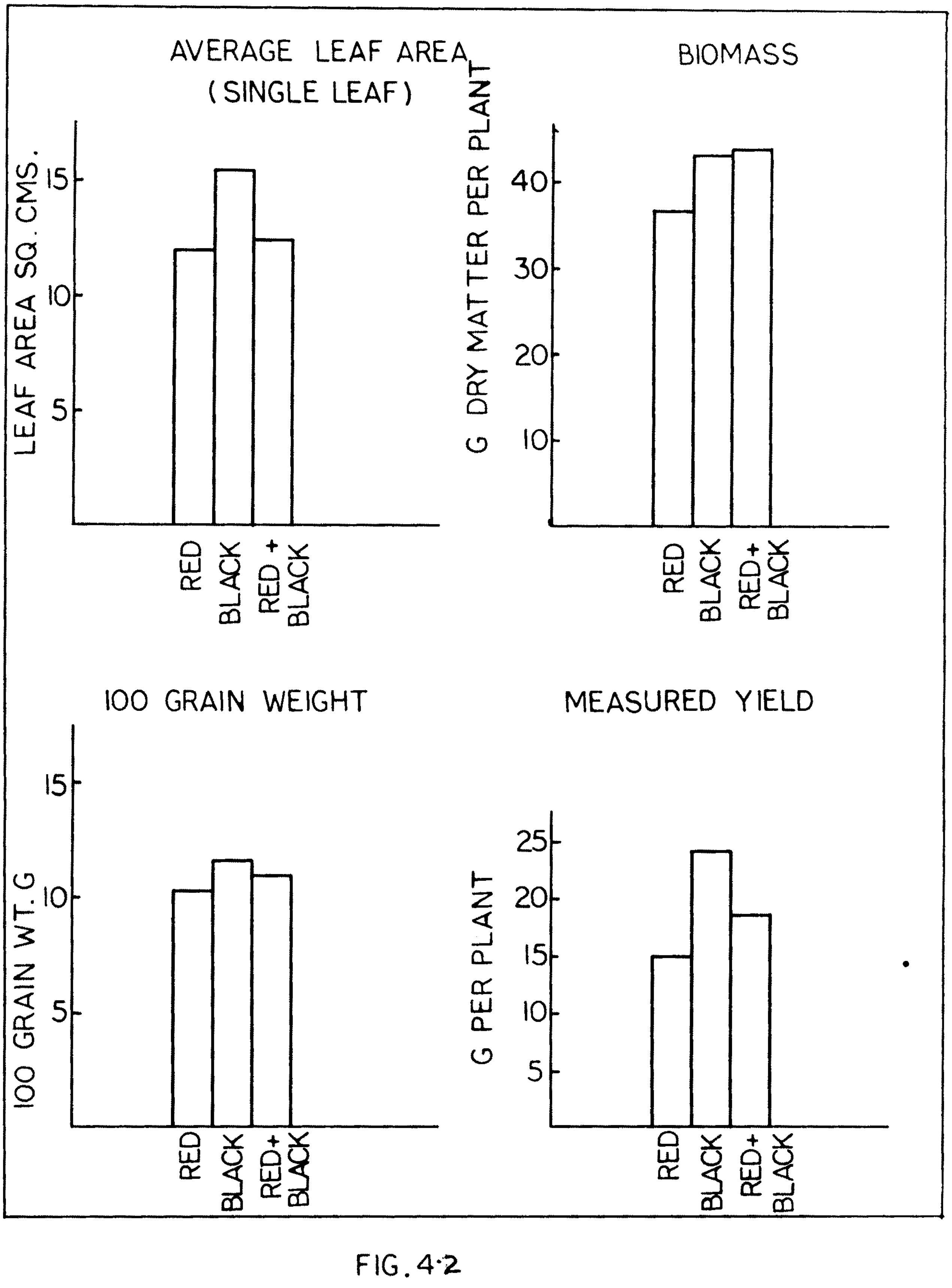
AVERAGE LEAF AREA
(SINGLE LEAF)
LEAF AREA SQ. CMS.
15
10
5
RED
BLACK
RED + BLACK
BIOMASS
G DRY MATTER PER PLANT
40
30
20
10
RED
BLACK
RED + BLACK
100 GRAIN WEIGHT
100 GRAIN WT. G
15
10
5
RED
BLACK
RED + BLACK
MEASURED YIELD
G PER PLANT
25
20
15
10
5
RED
BLACK
RED + BLACK

FIG. 4·2

As regards the root length, plants in the red + black soil have longer roots than the plants in the red and the black soils. As the plants in the black soil are tallest of all, deep root system in these plants may be expected. According to Cooper and Hurd (1968) and Cooper (1971), if the rooting medium is well aerated and constantly supplied with adequate water and nutrients, other conditions being favourable, very restricted root systems can support considerable shoot growth. In the present investigation the taller plants in the black soil have shorter root system, indicating possibly adequate supply of water and nutrients. Secondly the root growth is related to the texture of the soil. Kar et al. (1979) have shown that particle and pore size and distribution controls root growth of rice plants. This explains why root length in the red soil is more.

The root length of all the plants growing in different soils is comparatively shorter than the other leguminous crops. The root system of legumes is a primary tap root system in contrast to fibrous adventitious and secondary nature of that in the grasses. The depth of the root penetration in the soybean and groundnut may be 1.5 m or more (Smartt, 1976).

Average shoot/root ratio is higher in the plants growing in the black soil. The reason for low shoot/root value in the plants in the red + black soil is comparatively short shoot length and maximum root length.

Average leaf area of a single leaf is minimum in the plants growing in the red soil while it is higher in the plants growing in the black soil. According to Vanek (1965) variations in the size and shape of leaves are due to the degree of light received, the age of the tree, the fertility of the soil and the climate. According to him leaves of mature trees are usually larger than those of small ones and leaves are somewhat larger at the top of trees. The leaves formed early in the season usually continue to increase in size throughout the entire season, except for a period of drought. Leaves formed during a drought are significantly smaller. The results obtained in the present investigation can be explained on this basis. It can be seen from the foregoing discussion that the plants in the black soil receive more light as compared to those in the red soil. Thus the increased light intensity results in more leaf area. The contribution of leaf area towards yield has been amply proved. Recently Hunter (1980) has shown in case of maize that increase in leaf area results in more grain yield. In pigeonpeas, defoliation during the reproductive phase reduces the yield by reducing the number of pods per plant but has little or no effect on seed number per pod and weight per seed (Hammerton, 1975; Anon, 1978). Although the leaf area given here is of a single leaf, it is the average value of 30 leaves randomly selected. It must be noted here that the pods are developed in the axil of the leaf. Therefore as a photosynthesis assimilate source each leaf is important and the area measured even for a single leaf will lead to better understanding of the role of soil in plant growth. Overall growth of the plant is controlled by the fertility status of the soil. As the black soil is heavy growth pattern obtained in this soil is better.

Average number of branches per plant is minimum in the plants growing in the red soil while there is not much difference in the number of branches growing in the black and the red + black soil. Average number of branches per plant contributes towards the yield of plant. Many workers like Tikka et al. (1976), Aggarwal and Kang (1976), Wakankar and Yadav (1976), Bahl et al. (1976), Banerjee et al. (1977), Ram et al. (1977) and Bennett et al. (1977) have supported this aspect. However this is not the only factor that decides the yield of the plant. The angle of the branch orientation also plays important role. Average branching angle is maximum in the plants growing in the black soil while it is minimum in the plants growing in the red soil. Plants growing in the red + black soil show intermediate branching angle. As the branching angle is maximum in the plants in the black soil the incident sunlight is received more by the leaf surface that will cause increase in the photosynthetic efficiency. While the plants in the red soil have low branching angle resulting in the low photosynthetic yield. Plants in the red + black soil are having intermediate branching angle, their yield is also an intermediate to that of the plants in the black and the red soil. This can be seen in yield per plant as well as calculated yield per hectare. As has been stated above the increase in branching angle is responsible for increased leaf area which is, in turn, correlated to yield.

The difference in the average number of seeds per pod is not very significant. These values for plants in the red, the black and the red + black soils are 3.3, 3.5 and 3.4 respectively. But this slight difference also counts for the increase in the yield of the plant. Bahl et al. (1976) reported in *Cicer arietinum*, number of seeds per pod gave maximum direct effect towards the yield. Tikka et al. (1976) reported in *Phaseolus aconitifolius* that the grain yield is positively correlated with the grains per pod. Similar observation was made in lentil (*Lens culinaris* Medic) by Wilson (1978). Average number of pods per plant is maximum in the plants in the black soil. It is minimum in the plants in the red soil while plants in the red + black soil have intermediate number of pods per plant. This also contributes towards the yield of the plant. Wakankar et al. (1975) reported in *Pisum sativum* the number of pods per plant is positively correlated with the yield of the plant. Aggarwal and Kang (loc. cit.) made similar observation in horse gram (*Dolichos biflorus* L.) Bahl et al. (1976) and Ageeb and Ayoub (1977) in *Cicer arietinum*, Tikka et al. (1976) in *Phaseolus aconitifolius*, Gunaseelan and Hanumantha Rao (1976) and Wakankar and Yadav (1976) in *Cajanus cajan* and Banerjee et al. (1977) and Dahiya et al. (1979) in *Phaseolus mungo* reported the yield of the plant is significantly correlated with the number of pods per plant. In the present investigation as the plants in the black soil have maximum number of pods per plant the yield of the plant is expected to be higher while the plants in the red soil have minimum number of pods so the yield of these plants is obviously expected to be minimum. This is confirmed by hundred grain weight which is maximum (11.66 g) in the plants growing in the black soil, it is minimum (10.25 g) in the plants growing in the red soil while plants in the red + black soil have intermediate value of 100 grain weight. The present values are higher as compared to the 100 grain weight of C. cajan var. T-21 which is 3.2 to 3.4 g. The given characteristics of C. cajan var. T-84 show 100 grain weight is 9.5 g and mean yield per hectare is 670 kg. As compared to this the present yields are higher. The grain weight is the main parameter of yield and is important from the point of view of production. The grains being the edible part and source of proteins, more value is attached to the weight of the grains. The importance of pulses is not only from the point of view of grain production but also from other angles. The dried leaves and stem parts etc. are ground to "bhusa" and used as cattle feed. From this stand point the dry matter production per plant - the biomass - is another characteristic adding importance to the plant. The present study records significant difference in biomass of plants in the red and the black soils.

The biomass of the plants in the black soil is highest, this might be due to their tall habit while it is lower in the plants in the red soil due to their less height. Jain (1978) reported that the climatic conditions do not affect production, of Setaria glauca but the combined effects of many stresses like habital conditions, topographic or micro edaphic conditions and intrinsic behaviour of species etc. have a significant role. His observation supports the present work which indicates the role of soil (habitat) in plant growth.

In all the growth parameters so far studied the plants in the red soil show poor growth while plants in the black soil are comparatively better. Plants in the red + black soil stand in between the above two.

Measured yield per plant is maximum in the plants in the black soil and it is minimum in the plants in the red soil. Plants in the red + black soil stand in between the above two as regards the yield. There are number of factors which influence the yield of plants in the black soil. The leaf area, branching angle, number of branches per plant, average number of seeds per pod, number of pods per plant, 100 grain weight are maximum in the plants in the black soil, so the yield of these plants is high. In the plants in the red soil these characteristics show lower level. So the yield of these plants is minimum.

For better understanding the measured yield has been converted to hectare basis. The calculated yield per hectare is maximum in the black soil while it is minimum in the red soil. Plants in the red + black soil stand in between the above two as regards the calculated yield per hectare. Vaidya *et al.* (1978) reported 790 kg per hectare yield of *Cajanus cajan*. The results obtained in the present investigation in the black and the red + black soil are comparatively higher, while those of the red soil are very near to the results reported by Vaidya *et al.* (*loc. cit.*). The yield of *Tur* (*C. cajan*) has been reported several times from different localities. On an average *C. cajan* produces 1100 - 4400 kg/ha green pods which may increase in certain cases to 8800 kg/ha. The yield of dry grains has been reported as 500 - 1100 kg/ha (Codd *et al.*, 1975). The present report is within the range and indicates that eventhough *Tur* is supposed to be fit for a broad range of soil type, it gives higher yields on heavy soil (1498 kg/ha).

In the days of crises of food grains in general, and pulses in particular, the major pulse crop of Maharashtra should be studied for its efficiency of production. The present piece of work has clearly indicated that *C. cajan* var. T-84 should be taken on richer soils which will give more yields and more biomass for cattle feed. With proper care of the crop the yields may be still improved. Although *C. cajan* var. T-84 is a drought resistant variety, as it is supposed, it shows better performance with adequate water and nutrients. The study indicates that the major pulse crop like *C. cajan* should receive more attention with special reference to type of soil in which crop is to be grown. The consideration will help, to some extent in solving the problems of increased pulse production.

The growth analysis has lead to the conclusions that the type of soil affects the yield of C. cajan by affecting :

1) total height of the plant
2) total number of branches/plant
3) leaf area
4) branching angle
5) number of pods/plant
6) number of seeds/plant
7) the weight of 100 seeds
8) biomass production.