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EFFECTS OF ONTOGENETIC STAGES, LEAF POSITION AND COLOUR RATING ON CO_2 ASSIMILATION IN *PHASEOLUS VULGARIS* L., UNDER FIELD CONDITIONS

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Abstract

CO_2 assimilation rate in beans (*Phaseolus vulgaris* L.) was investigated under field conditions. The rate of CO_2 assimilation in leaves was significantly affected by ontogenetic stages, leaf position and their interactions. Maximum CO_2 assimilation rate (15.332 mg CO_2/dm^2 hr^{-1} was recorded at flowering stage followed by budding whereas, among the leaf positions, the higher rate of (14.985 mg CO_2/dm^{-2} hr^{-1} was observed in upper leaves followed by central and lower leaves. Both leaf area and dry matter accumulation was higher at the pod forming stage, highest CO_2 assimilation was recorded in deep green leaves followed by light green and yellow leaves. CO_2 assimilation rate drastically reduced after pod formation as the case with dry matter accumulation and leaf area. CO_2 assimilation was maximum in upper as well as deep green leaves as compared to lower leaves with light green or yellow colouring.

Introduction

The common bean (*Phaseolus vulgaris* L.) is an annual legume cultivated for its green pod and dry seed. Like all physiological processes photosynthesis (CO_2 assimilation) in *Phaseolus* is influenced by a number of external and internal factors such as light intensity, leaf position and ontogenetic stages of the plant (Gordon *et al.*, 1982; Jamro & Larik, 1990). There was an intrinsic ontogenetic pattern of gas exchange for each been leaf modified by events taking place during development in other parts of the plant such as subsequent leaf emergence or flowering (Fraser & Leggeth, 1984). The increase in CO_2 uptake occurred in each leaf at the time of flowering and maximum photosynthesis rate varied with leaf position on the plant (Jwoodward, 1976). Visual colour rating was correlated with chlorophyll content of the leaves (Johnson & Ohki, 1981). Aase (1971) & Furgoson *et al.*, (1972) observed that the chlorophyll content, dry matter production, photosynthesis and specific leaf weight were lower for light coloured plants compared to dark plants. Besides, there are various environmental factors that may influence the rate of photosynthesis and the diurnal fluctuation under which each of those may limit the rate of CO_2 assimilation.

The present study was carried out to determine the relative effects of ontogenetic stages, leaf position and leaf colouring rate on CO_2 assimilation in *P. vulgaris* under field conditions.

Materials and Methods

A field experiment was conducted in garden soil on field beans (*Phaseolus vulgaris* L.) Motalskobelia inoculated with *Rhizobium phaseolus* (Strain 682). The experiment

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Table 1. CO_2 assimilation rate (mg $CO_2/dm^{-2}hr^{-1}$) in different leaves during different ontogenetic stages of growth in *Phaseolus vulgaris* under field conditions.

Growth/leaf stages position	Upper leaf	Central leaf	Lower leaf	Mean
Budding	19.018	14.01	05.845	12.958
Flowering	23.425	15.032	7.538	15.332
Pod forming	20.325	10.452	3.465	11.414
Seeding	8.745	5.225	1.992	5.321
Maturity	3.412	2.705	0.815	2.311
Mean of leaf	14.985	9.485	3.931	---

Table 2. Analysis of variance for rate of CO_2 assimilation as influenced by ontogenetic stages and leaf position in *Phaseolus vulgaris* under field conditions.

Source of variation	d.f	M.S	Level of significance
Block	3	000.065	NS
Growth stages	4	356.311	$P<0.001$
Leaf position	2	610.959	$P<0.001$
GSxLP	8	039.608	$P<0.001$
Error	42	---	---

was laid out in completely randomized block design with four blocks, 10 plants per block were randomly selected for studying the photosynthetic rate influenced by ontogenetic stages, leaf position (upper, central and lower leaves) and colour rating (deep green, light green, and yellow green). Atleast 50 readings for each observation were recorded for studying the rate of CO_2 assimilation (mg CO_2/dm^{-2} hr^{-1}).

CO_2 assimilation intensity was measured by infra red gas analyser Gip_{10} MB_2 model by using a mobile gas exchange laboratory and leaf area was determined with the help of automatic leaf area meter. The Carbon Exchange Rate (CER) was calculated from the differences in CO_2 concentration, volume, flow of air through the measurement chamber and the leaf area.

Results and Discussion

Maximum CO_2 assimilation (15.332 mg/CO_2/dm^{-2} hr^{-1}) was recorded during flowering stage among the ontogenetic stages which drastically decreased after pod formation (Table 1). CO_2 assimilation rate (mg CO_2/dm^{-2} hr^{-1}) was significantly (P/0.001) affected by ontogenetic stages, leaf position and their interaction (Table 2). Among the different

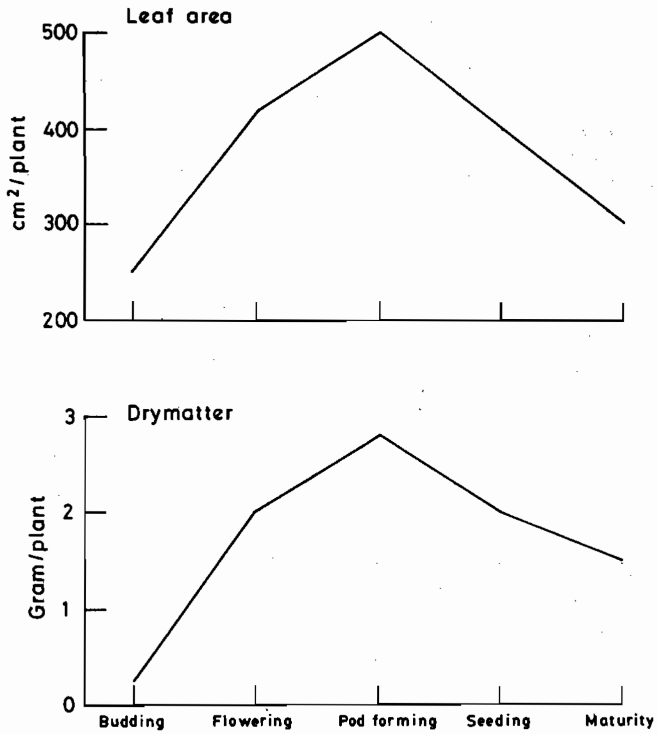

Fig.1. Leaf area and dry matter accumulation of *Phaseolus* during ontogenetic stages.

leaf positions, maximum carbon assimilation was observed in upper leaf (14.985 mg CO_2/ dm^{-2} hr^{-1}) followed by central and lower leaf. Maximum photosynthesis (23.425 mg CO_2/dm^{-2} hr^{-1}) was recorded during flowering in upper leaves and minimum (0.815 CO_2/dm^{-2} hr^{-1}) was noted during maturity in the lower leaves.

Maximum CO_2 assimilation was noticed in deep green leaves followed by light green and yellow leaves in upper portion (Table 3). However, CER remained higher during middle of day in all visual colour ratings. Growth analysis showed that among the ontogenetic stages, higher leaf area and dry matter accumulation was observed during pod forming stage followed by budding stage (Fig.1). These results are in agreement with those reported by Gordon *et al*., (1982), Jwoodward (1976) and are in close agreement with the findings of Jamro & Larik (1990).

Table 3. CO_2 assimilation (mg $CO_2/dm^{-2}hr^{-1}$ affected by visual colour rating in *Phaseolus vulgaris* under field conditions.

Timings	Deep green leaves	Light green leaves	Yellow leaves
09.00	9.16*	6.23	3.13
09.30	9.12	4.32	2.22
10.00	12.32	6.88	3.67
10.30	12.89	7.14	4.06
11.00	14.12	8.24	4.89
11.30	10.23	6.23	3.99
12.00	09.33	5.34	2.91
12.30	16.23	9.41	4.10
13.00	17.45	10.35	4.41
13.30	16.09	10.11	4.01
14.00	08.38	6.43	3.51
14.30	15.45	7.59	3.91
15.00	15.11	7.19	2.90
15.30	10.91	6.00	2.11
16.00	11.12	6.29	2.30
16.30	8.15	4.42	2.10
17.00	8.55*	4.69	2.39

* = Each reading is average of 10 - readings.

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