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CONCEPT OF IDEAL PLANT TYPE (IDEOTYPE) IN HORSEGRAM (*DOLICHOS BIFLORUS* L.)

M. Swapna, Achamma Oommen, K. M. N. Namhoodiri and Luckins C. Babu
Kerala Agricultural University, Vellanikkara 680 654, Trichur, India

Abstract: The concept of an ideal plant type in horsegram was studied based on crop growth rate (CGR), net assimilation rate (NAR), leaf area index (LAI) and harvest index (HI). A plant type with peak CGR, NAR and LAI at the middle growth period was found to be the best. Efficient partitioning of the total dry matter produced towards the reproductive parts was very important for a higher harvest index.

Key words: CGR, harvest index, horsegram, LAI, NAR.

INTRODUCTION

Pulses are important sources of dietary protein. Horsegram can resist severe drought conditions and is often referred to as `poor man's pulse' because of its low cultivation cost. Nonavailability of high yielding strains and lack of sufficient information for further improvement prevent its extensive cultivation. The productivity of any crop community is dependent on its inherent capacity for photosynthesis and photosynthetic area developed. Thus, genotypic variation in the productivity of a crop may be related to parameters like net assimilation rate (NAR), crop growth rate (CGR), leaf area index (LAI) and harvest index (HI). The objective of this investigation was to evaluate NAR, CGR, LAI and HI of 12 varieties of horsegram and relate these to productivity.

MATERIALS AND METHODS

Field experiments were carried out in the experimental fields of the College of Horticulture, Vellanikkara, Trichur. Twelve varieties of horsegram were used for the study. The seeds were sown in randomised block design with two replications at a spacing of 30cm x 25cm. The plants were subjected to destructive sampling at 10 days interval, starting from the 10th day of sowing. The plants were randomly selected and tagged. Three plants were uprooted at each sampling. The roots were not taken. Then they were separated into stem, leaf and reproductive parts (during reproductive phase). All the components were dried at 80° C for 48 hours and then weighed. CGR, NAR and LAI were computed. Leaf area was calculated according to the formula leaf area = Length x breadth of terminal leaflet x 1.72 (Manian *et al.*, 1990).

RESULTS AND DISCUSSION

In any crop, proper assessment of growth pattern is very important for the evolution of a good plant type. Various growth parameters like growth rate, branching pattern, assimilation rate, partitioning of assimilates etc. help for the selection of an ideal plant type which will be useful for further crop improvement.

Crop growth rate (CGR) is the dry weight gained by unit area of the crop in unit time. The results obtained indicated that CGR of all the varieties increased steadily up to 40-50 days of sowing in short and medium duration varieties and then rapidly decreased (Table 1). Varietal differences were not significant during the early stages. Of all the genotypes, V_{37} (IC No. R5) showed the highest CGR and V_{35} (IC 33050) the lowest during the mid-growth phase (40-50 days in short duration types and 60-70 days in long duration types). The initial slow increase in CGR up to 45 days could be associated with poor growth of the stem and leaves. There was a rapid increase during the next 10 days and this rapid increase resulted in increased accumulation of dry matter in reproductive organs. A higher NAR in turn leads to increase in CGR. Koiler *et al.* (1970) has reported similar observations in soyabean.

The net assimilation rate (NAR) is the increase in plant weight per unit area of assimilatory surface per unit time. The NAR showed a

Table 1. Crop growth rate at various growth stages, g m^{-2} day^{-1}

Geno-type	Interval of sampling, days										
	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100	100-110	110-120
V6	0.26	0.87	1.58	4.67	6.93	10.43	12.84	12.52	2.87	0.41	0.41
V22	0.31	0.95	1.94	9.52	6.09	5.71	-	-	-	-	-
V31	0.20	0.55	1.52	8.61	9.45	12.87	4.32	-	-	-	-
V34	0.23	0.81	1.24	11.25	10.09	11.82	9.75	3.18	-	-	-
V35	0.19	0.49	1.36	8.12	7.53	11.87	3.34	-	-	-	-
V37	0.30	0.46	1.44	7.83	5.57	18.91	16.75	13.44	12.35	7.88	2.81
V40	0.13	2.77	4.62	11.00	7.90	4.25	-	-	-	-	-
V42	0.32	0.55	5.42	10.56	7.56	7.46	4.96	-	-	-	-
V43	0.32	2.85	7.45	16.18	9.43	7.62	-	-	-	-	-
V44	0.27	1.09	7.72	14.52	11.26	4.19	3.47	-	-	-	-
V46	0.23	0.61	1.84	8.13	4.68	7.36	6.39	-	-	-	-
V49	0.17	0.57.	4.71	9.56	4.62	8.22	8.14	3.97	-	-	-

Table 2. Net assimilation rate at various growth stages, g m^{-2} day^{-1}

Geno-type	Interval of sampling, days										
	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100	100-110	110-120
V6	0.18	0.14	0.16	0.20	0.11	0.20	0.19	0.02	0.01	0.01	0.01
V22	0.21	0.16	0.14	0.31	0.25	0.13	-	-	-	-	-
V31	0.18	0.18	0.18	0.29	0.22	0.18	0.08	-	-	-	-
V34	0.16	0.10	0.17	0.33	0.17	0.14	0.01	-	-	-	-
V35	0.14	0.08	0.08	0.23	0.18	0.25	0.08	-	-	-	-
V37	0.20	0.06	0.10	0.12	0.23	0.33	0.09	0.12	0.01	0.01	0.01
V40	0.18	0.12	0.84	1.48	0.72	0.09	-	-	-	-	-
V42	0.10	0.09	0.07	0.23	0.21	0.15	0.09	0.01	-	-	-
V44	0.01	0.18	0.09	0.31	0.11	0.02	0.07	0.07	-	-	-
V46	0.14	0.09	0.29	0.22	0.14	0.11	0.11	-	-	-	-
V49	0.12	0.16	0.14	0.18	0.12	0.16	0.15	0.77	-	-	-

Table 3. Leaf area index at various growth stages

Genotype	Days after sowing											
	10	20	30	40	50	60	70	80	90	100	110	120
V6	0.08	0.12	0.26	0.31	1.28	1.42	1.99	1.96	1.95	1.94	1.95	1.9
V22	0.01	0.12	0.57	1.29	1.31	1.29	1.27	-	-	-	-	-
V31	0.01	0.08	0.25	1.53	1.57	1.56	1.41	-	-	-	-	-
V34	0.01	0.48	1.43	2.03	2.94	2.94	2.53	1.56	1.40	-	-	-
V35	0.01	0.47	0.88	1.15	1.22	1.27	1.20	-	-	-	-	-
V37	0.01	0.12	0.35	0.87	1.47	1.73	2.10	2.07	2.01	1.96	1.95	-
V40	0.01	0.60	1.41	1.85	2.98	1.49	1.13	-	-	-	-	-
V42	0.01	0.10	1.23	1.50	1.51	1.44	1.39	-	-	-	-	-
V43	0.05	0.10	0.24	1.36	2.15	1.90	1.79	-	-	-	-	-
V44	0.01	0.27	0.09	1.43	1.48	1.46	1.42	1.21	1.20	-	-	-
V46	0.01	0.29	1.00	1.26	1.29	1.27	1.26	1.17	-	-	-	-
V49	0.09	0.23	1.00	1.36	1.56	1.51	1.48	1.39	1.01	-	-	-

decrease at the initial stage, then increased to a peak value at 40-50 days for short and medium duration varieties and 60-70 days for long duration genotypes. Then there was a decline (Table 2). The peak was highest for V_{40}(IC No.24) and lowest for V_{49}(IC 22804) at mid-growth phase. The initial decline in NAR might he due to excessive mutual shading and an increase in old leaves with low photosynthetic efficiency. Kalubarme and Pandey (1979) and Saini and Das (1979) have recorded a similar trend in greengram. The increase in NAR during middle stage may he the result of greater demand for assimilates by the rapidly growing seeds. An increase in the production of photosynthates by green pods could be another reason as observed by Kollar *et al.* (1970) in soyabean.

LAI also showed a similar trend, increasing right from the initial stages, reaching a peak at 40-50 days after sowing (DAS) and then decreasing slightly (Table 3). V_{40} (IC No. 24) had the maximum LAI. V_{35} (IC 33050) had the lowest value, at the middle growth period. The highest value of NAR also, recorded by V_{40} indicates a positive association between the two parameters LAI and NAR. An increase in LAI causes an increase in photosynthetic area and thus the net assimilation increases. During the final stages the decline shown might be due to the presence of older leaves, which do not retain photosynthetic efficiency but have respiration activity. Similar findings were reported by Prasad *et al.* (1978) in gram, Kalubarme and Pandey (1979) in greengram and Mehra *et al.* (1987) in pigeon pea.

Harvest index (HI) which is the ratio of economic yield to biological yield was also calculated. This was also highest in V_{40} (IC No.24) (Table 4). In this genotype total dry matter (TDM) was not very high, but the better partitioning of the photosynthates to the reproductive parts (178.19 g of seeds per unit area of land and 255.7 g of TDM per unit area of land) resulted in a higher HI. In genotypes

V_{34} (TCR 723; 1C 241) and V_{37} (TCR 364; IC No. R5) which showed higher TDM values, the partitioning to the reproductive dry matter was very low thereby leading to a lower harvest index. In these genotypes, a higher percentage of TDM has been produced during preanthesis stage. LAI and NAR were also low in these cases. The importance of efficient partitioning of dry matter for higher harvest index had been reported by Prasad *el al.* (1978) in gram, Kalubarme and Pandey (1979) in greengram, Uprety *?l al.* (1981) in soyabean, Mehra (1987) in pigeon pea and Singh (1990) in horsegram. The present findings are in accordance with these.

Thus a plant type with the maximum leaf area and highest net assimilation rate during the middle of its growth phase (40-50 days in short and medium duration varieties) will be the ideal one for good performance. There should be an efficient partitioning of photosynthates towards the reproductive parts which is very important for higher HI. Future selections in horsegram should be based on these aspects.

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