Indian J. Plant Physiol., Vol. 15, No. 1, (N.S.) pp. 84-89 (Jan.-Mar., 2010)

SHORT COMMUNICATION

PERFORMANCE OF ASALIO (*LEPIDIUM SATIVUM* L.) GENOTYPES UNDER SEMI-ARID CONDITION OF MIDDLE GUJARAT

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Received on 26 Oct., 2009, Revised on 18 March, 2010

SUMMARY

Asalio (*Lepidium sativum* L.), is a low water requiring medicinal herb: the roots, leaves and seeds are used for different medicinal preparations. A field experiment was conducted to assess the response of five important lines (No. 99, No. 31, No. 37, No. 16 and No. 53) and one cultivar (GA-1) of Asalio in terms of leaf photosynthetic characteristics, growth and grain yield. The results revealed that there was wide variability in different genotypes with regard to all these above parameters. A line, No. 16 exhibited maximum growth in terms of all these characters. Maximum seed yield of 18.1 q ha^{-1} was also obtained in No. 16 with a harvest index (HI) of 32.2 % and test weight (1000 seed weight) of 1.76 g, which was the maximum among all the genotypes. The significant variability among the genotypes with respect to all these above determinants indicates the utility of the line No. 16 under semi-arid condition.

Key words: **Growth, leaf area, *Lepidium sativum*, photosynthesis, yield**

Asalio or Chandrasur (*Lepidium sativum* L.) also known as Garden cress, garden pepper cress, pepper grass or pepperwort is a fast-growing edible plant. In India, Garden Cress is an important medicinal crop of Malwa plateau of Madhya Pradesh grown in winter season (Tiwari and Kulmi 2004) and is also cultivated in Uttar Pradesh, Rajasthan, Gujarat, Maharashtra and Madhya Pradesh in rabi season for achieving high yield. It is an annual erect herbaceous plant growing upto (≥) 30 cm. Agriculturally, cress are considered among the most important species of the genus of the family of mustards i.e. Brassicaceae. It is an important green vegetable consumed by human beings, most typically as a garnish or as a leafy vegetable. The plant is known to possess varied medicinal properties. Leaves are diuretic and gently stimulant (Maghrani *et al*. 2005). The seeds are aperients, diuretic, tonic, demulcent, aphrodisiac, carminative, galactagogue and emmenagogue (Nadkarni, 1954), rubefacient and for hurts and sprains (Chopra *et al*. 1986), tetragenic effect (Nath *et al*. 1992), antiovulatory properties (Satyavati 1984), treatment of secondary syphilis and tenesmus (Chopra *et al.* 1986).

It is important to develop high yielding cultivars of asalio for which morpho-physiological characters like leaf photosynthesis and related characteristics are important parameters to be studied. Therefore, a field study was conducted to assess the variation in leaf photosynthetic characteristics and to find out their relationship with seed yield in different Asalio genotypes under semi-arid condition of Gujarat.

A field experiment was conducted at research farm of Directorate of Medicinal and Aromatic Plants

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Research, Boriavi, Gujarat, India located at 22.5° N latitude and 73.0° E longitudes. The study was carried out in 2004-06 taking five important lines viz. No. 99, No. 31, No. 37, No. 16 and No. 53 and one cultivar (GA-1) of Asalio. The study area falls under the climatic zone VII of semi-arid region of India and was carried out in winter (*rabi*) season under irrigated condition. The crop was sown in second week of November in both the years. Crop was applied with 10 t ha^{-1} of FYM only with uniform intercultural operations and only four irrigations at the time of sowing, branching at 40 days after sowing (DAS), emergence of inflorescence (at 60 DAS) and at 90 DAS. The crop was raised in 48 m^2 plot for each genotype at 30 cm row spacing with a seed rate of 4 kg ha^{-1}. Crop was harvested at 120 DAS, seed and straw yield were recordeded after the harvest.

Different parameters related to growth and physiological aspects such as dry weight, specific leaf mass (SLM), etc. were recorded at 45 (branching), 60 (emergence of inflorescence) and 75 DAS (spikelet initiation). Leaf area was determined per plant basis using LI-COR Model LI-3100C Area meter, USA and leaf area index (LAI) using Plant Canopy Analyzer Model LAI-2000 and Sensor Model LAI-2050 PCH-1779, USA.

Photosynthetic rate (Pn) and respiration (Rn) were determined at 45, 60 and 75 DAS and yield and yield parameters were also assessed during harvest. Rate of photosynthesis (µ mol m^{-2} s^{-1}) and respiration (µ mol m^{-2} s^{-1}) of either 4^{th} or 5^{th} leaf from bottom were measured using Infra Red Gas Analyzer of LI-COR Model LI-6400 portable photosynthesis system, USA. At harvest total dry weight and seed yield were recorded which included seed yield, total biomass and test weight. Correlation and other statistical analysis were carried out using statistical software MSTAT 4.0 C package for computers (Michigan State University, USA) software following the method of Gomez and Gomez (1976).

The genotypes in the present study included No. 99, No. 31, No. 37, No. 16 and No. 53 including one cultivar (GA-1) of Asalio. The mean maturity days for all the cultivars are 104 days with a range of 98 (No. 37) – 110 days (No. 53). The seed yield varied between 12.4 (No. 99) to 18.1 q ha^{-1} (No. 16) with mean yield of 15.2 q ha^{-1} and mean harvest index (HI) of 28.6 % ranging between 25.7 (No. 99) and 32.2 (No. 16) (Table 1). The 1000 seed weight ranges from 1.58 g (No. 99) to 1.76 g (No. 16) with a mean of 1.68 g for all the cultivars (Table 1). The mean total dry matter (TDM) recorded at harvest was 30.4 g $plant^{-1}$ with a range of 24.1 (No. 99) to 38.3 (No. 16) (Table 1).

A high degree of variability was observed in photosynthesis and other related characteristics**.** The variation was highly significant (p=0.05) for all the characters at all the stages. Growth of plants in terms of plant height and shoot growth was significant and attained a maximum height of 102.9 cm (No. 16) at 75 DAS. Significant increase in growth in terms of shoot dry weight and root growth was observed particularly at 75 DAS (data not shown). Leaf growth was highly significant (p=0.05) at all the stages among the genotypes.

Based on replicated data, the association of rate of photosynthesis and related characters were worked out. Photosynthesis rate (A) was positively and significantly related to both transpiration rate and stomatal conductance at all the stages of growth. The specific leaf mass exhibited positive association with rate of photosynthesis at emergence of inflorescence (60 DAS) and at spikelet initiation stage (75 DAS). A positive association between SLM and TDM at harvest was observed. However, the relationship was significant only at spikelet initiation stage (75 DAS). Though SLM was positively related to seed yield, the relationship was not significant. Leaf area recorded exhibited a tendency of negative, though significant, association with rate of photosynthesis and SLM (Table 2).

A positive correlation was also observed between the total above ground biomass harvested at all the stages and rate of photosynthesis. However, the relationship was found to be significant only at emergence of inflorescence and spikelet initiation stage. Nevertheless, the photosynthesis rate showed positive and significant association with TDM recorded at harvest (Table 2). Seed yield had shown a non-significant positive association with leaf photosynthesis rate at all the stages. Results of photosynthesis and respiration revealed that rate of increase was higher initially between 45 and 60

Table 1. Yield and yield attributes of different asalio genotypes.

Genotypes	Plant height (cm) at harvest	Wt. of husk (g m^{-2})	No. of branches $plant^{-1}$	No. of racemes $branch^{-1}$	No. of racemes $plant^{-1}$	Raceme length (cm)	Single Raceme wt. (g)	No. of pods $raceme^{-1}$	Pod wt. $raceme^{-1}$ (g)	1000 seed wt. (g)	Total dry matter at harvest (g $plant^{-1}$)	Seed yield (q ha^{-1})	HI(%)
GA-1	95.3b	79.3de	17.7bcd	7.0c	99.7c	22.7c	0.71b	36.4bc	0.65c	1.61c	26.3bc	14.9bc	27.0bc
No. 99	86.5bc	74.5d	17.1cd	6.3c	78.1d	20.8c	0.70b	34.4c	0.68bc	1.58d	24.1c	12.4c	25.7c
No. 31	91.2bc	76.7d	18.3bc	7.3c	105.4bc	22.4c	0.69b	30.5d	0.71b	1.64cd	29.3b	14.6bc	27.1bc
No. 37	100.5ab	85.4b	19.4bc	10.0b	115.6bc	25.9b	0.73b	38.7b	0.73b	1.71b	31.1b	15.5bc	29.4ab
No. 16	106.3a	92.7a	23.5a	13.0a	127.6a	30.3a	0.80a	43.8a	0.78a	1.76a	38.3a	18.1a	32.2a
No. 53	98.5abc	81.3c	20.2b	9.0b	112.2b	27.0b	0.76ab	40.8ab	0.74ab	1.73ab	33.2b	15.8b	30.4ab
Mean	96.4	81.6	19.4	8.8	106.4	24.8	0.73	37.4	0.71	1.68	30.4	15.2	28.6
Cv (%)	2.85	12.36	15.30	14.01	7.24	12.06	18.03	10.47	10.95	2.33	12.51	2.76	8.97

The values followed by same letter are not significant. Each value is a mean of 9 replicates except seed yield and HI which were determined per plot. HI: Harvest index.

Table 2. Correlations between photosynthesis and related parameters in Asalio

S. No.	Parameter	45 DAS (branching)	60 DAS (emergence of inflorescence)	75 DAS (spikelet initiation)
I.	Photosynthesis (A) and			
	1. Stomatal conductance (gs)	0.51**	0.48**	0.41**
	2. Transpiration (T)	0.67**	0.52**	0.45**
	3. Internal CO_2 concentartion (Ci)	-0.39*	-0.42**	0.41**
	4. Specific leaf mass (SLM)	0.27	0.33*	0.37*
	5. Total dry weight (TDM)	0.29	0.31*	0.33*
	6. TDM at harvest	0.29	0.34*	0.36*
	7. Leaf area	-0.053	-0.054	-0.11
	8. Seed yield	0.28	0.24	0.23
II	A/T and			
	1. A/Ci	0.51**	0.55**	0.75**
	2. A/gs	0.88**	0.88**	0.82**
III	Specific leaf mass (SLM)			
	1. TDM at harvest	0.19	0.22	0.36*
	2. Seed yield	0.18	0.19	0.21

*p=0.05, **p=0.01

Fig. 1. Photosynthesis in different genotypes of Asalio at 45, 60 and 75 DAS. *indicates mean values of all the genotypes at different growth stages.
Data are mean value of (n=5) ±SD. CD (P < 0.05): 1.50 at 45 DAS, 2.33 at 60 DAS, 1.71 at 75 DAS.

Fig. 2. Respiration in different genotypes of Asalio at 45, 60 and 75 DAS.
'*' indicates mean values of all the genotypes at different growth stages.
Data are mean value of (n=5) ±SD. CD (P < 0.05): 0.093 at 45 DAS, 0.022 at 60 DAS, 0.091 at 75 DAS.

DAS than between 60 and 75 DAS: rate of photosynthesis (Pn) increased by 37% at 60 DAS than by 5% only at 75 DAS and likewise rate of respiration (Rn) by 11 and 6%, respectively (Fig. 1 and 2). Rate of photosynthesis varied between 10.12 (minimum) at 45 DAS (GA-1) to 20.88 µmole m^{-2} s^{-1} (maximum) at 75 DAS (No. 16) with mean range of 13.02 to 18.57 µmole m^{-2} s^{-1} from 45 to 75 DAS, respectively (Fig. 1).

Considerable increase in shoot growth in terms of plant height, tiller number (branches), leaf area was observed among the genotypes. A significant relationship was observed among some parameters at initial stages of crop growth which sustained growth at later stage and thus giving a yield of up to 18.1 q ha^{-1} (No. 16). The fact is further substantiated with the result of other yield parameters like number of branches, number of racemes, number of pods, etc. (Table 1). Among all the genotypes tried one particular line *viz*. No. 16 had exhibited maximum growth and gave maximum yield followed by No. 53. Incidentally, the only variety GA -1 and the line No. 99 had almost inferior result as compared to others (Table 1).

A strong association between SLM and photosynthesis was reported for different crops and it has been suggested that this simple parameter can be used as a surrogate for photosynthesis (Bhatia *et al*.

1996, Suresh *et al*. 1997). Genotypic variation in photosynthesis rate was often attributed to differences in SLM. But the relationship largely depends on species and may not hold true for all species and environments (Bhagasari and Brown, 1986). In this experiment two genotypes (No. 16 and No. 53) showed good agronomic traits, including tolerance to only three irrigation and to high temperature later in the month of March when temperature shot upto 35ºC unlike a considerable growth at initial stage at 45 and 60 DAS when the temperature ranged between 29-12°C (November to January), making them potentially suitable for cultivation in the semi-arid region of Gujarat and other suitable areas.

Leaf area exhibited a tendency of negative, though non-significant, association with rate of photosynthesis (Pn) and SLM. Negative association between Pn and leaf area was reported for different crop species (Barnes *et al*. 1969, Planchon, 1969, Evans and Dunstone, 1970). Studies on $^{14}CO_2$ fixation in finger millet showed that the rate of carbon fixation per unit leaf area was two fold higher in genotypes with less leaf area having high dry matter production (Shashidhar *et al*. 1983). In fact, regular correlation between leaf photosynthesis and yield has been very difficult to demonstrate in the field due to the fact that Pn is often negatively related with leaf area (Wilson, 1984). The negative association observed between leaf photosynthesis rate and leaf area in the present study supports this observation. However, it could be concluded that there is some scope to select/ breed for enhanced optimum LAI types to increase productivity as also reported by Raju *et al*. (2007) in case of sunflower.

The total dry matter recorded at harvest was however, significantly associated with seed yield (r= 0.59) at p= 0.01). This suggests that selection for high biomass types would result in productive genotypes. There was enough observation about one particular genotype viz. No.16 which could be further used for further breeding work and the work should be directed towards increasing yield and eliminating certain wild characteristics such as lodging which was observed in some genotypes viz. No. 99, No. 31, No. 37 and less in GA-1. The significant variation among genotypes in terms of A/T ratio and its positive association with A/Ci ratio and the significant association between A/gs ratio and A/T suggest that the carboxylation efficiency of the leaf has a strong bearing on leaf water use efficiency and it has been suggested that this ratio determine the potential water use efficiency of the leaf.

The significant variability among the genotypes with respect to all these above determinants also indicates the utility of the line No. 16 with respect to increased growth and yield under semi-arid condition.

ACKNOWLEDGEMENTS

Author thanks Dr. S. Maiti, Director, Directorate of Medicinal and Aromatic Plants Research, Boriavi, Anand, Gujarat for providing infrastructural and research facilities for this work.

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