Indian J. Plant Physiol., Vol. 9, No. 3, (N.S.) pp. 283-287 (July-Sept., 2004)

PHYSIO-MORPHOLOGICAL ANALYSIS OF RAPESEED MUSTARD CULTIVARS

MANZER HUSSAIN SIDDIQUI AND FIROZ MOHAMMAD*

Department of Botany, Aligarh Muslim University, Aligarh-202 002, India

Received on 12 Sept., 2003, Revised on 20 Aug., 2004

SUMMARY

Seven cultivars of rapeseed mustard viz. IGC-01 and Pusa Gaurav of *Brassica carinata*, Jagannath, Kranti, Rohini and TERI (0E) M21-Swarna of *Brassica juncea* and Hyola PAC-401 of *Brassica napus*, were evaluated in a randomized complete block design field experiment. Shoot length per plant, leaf number per plant, leaf area index, fresh weight per plant, dry weight per plant and net assimilation rate were studied at 45 and 60 days after sowing to assess their growth performance. Carbonic anhydrase activity, nitrate reductase activity and leaf NPK content were estimated at above stages. At maturity, pod number per plant, seed number per pod, 1000-seed weight, seed yield, oil percentage and oil yield as well as fatty acid composition of oil were estimated. The data revealed the overall superiority of Hyola PAC-401, which produced highest yield of seed and oil. It was followed by TERI (0E) M21-Swarna, which showed parity with Rohini. In comparison, Kranti performed poorly. It was also confirmed that the oil of Hyola PAC-401 and TERI (0E) M21-Swarna, was almost free from erucic acid and could, be preferred for human consumption.

***Key words*: Fatty acid composition, growth, rapeseed-mustard, yield.**

INTRODUCTION

Rapeseed-mustard is the second most important edible oil crop in India after groundnut. Inspite of increased production of oil and fats in our country in recent years, the demand is much higher in view of increasing population and improved standard of living of the people. The situation compels the government to import huge amounts of edible oil every year. Moreover, the oil of rapeseed-mustard contains high content of erucic acid which may cause cardiac problems. Oilcake, the by-product obtained after extraction, abounds in glucosinolates that are harmful to the animals feeding on it. To overcome these problems, plant breeders have been trying to evolve varieties having improved yield and nutritional quality. Lately, recourse to exploitation of genetic resources for raising the yield ceiling through generation of vast variability by synthesis of artificial alloploids, cytoplasmic hybridisation and transfer of novel genes has yielded encouraging results. Thus, several new varieties with desired characters have been evolved and are in the trial stage. Present study was conducted to analyse and compare the performance of above varieties in the field on the basis of their physio-morplogical differences in growth, yield and quality.

MATERIALS AND METHODS

A field experiment was conducted during rabi at the Farm-cum-Botanical Garden of the Aligarh Muslim University, Aligarh. The recommended dose of 80 kg N,

* Corresponding author

18 kg P and 30 kg K/ha was applied uniformly to the soil (texture sandy loam, pH 7.8, conductivity 0.67 dS/m, available nitrogen 207.8 kg N/ha, phosphorus 13.3 kg P / ha and potassium 298.8 kg K/ha. Half of the dose of nitrogen together with the full dose of phosphorus and potassium was applied at the time of sowing. The remaining nitrogen was added as top-dressing after one month of sowing. Nitrogen was applied as urea, phosphorus as monocalcium superphosphate and potassium as muriate of potash. Seeds of seven rapeseed-mustard varieties (IGC-01 and Pusa Gaurav of *Brassica carinata*, Jagannath, Kranti, Rohini and TERI (0E) M21-Swarna of *Brassica juncea* and Hyola PAC-401 of *Brassica napus)* were sown at the rate of 10 kg/ha. The seeds were sown by recommended method in 10 sq m plots. The furrows were kept 20 cm apart and seed distance was maintained 15 cm apart. The experiment was performed according to the randomised complete block design with three replications. Weeding was undertaken twice. The crop was irrigated thrice during the entire growth period and was kept free from insect pests by spraying 'Dimecron-100'.

The growth parameters,viz. shoot length per plant, leaf number per plant, leaf area index, fresh weight per plant, dry weight per plant and net assimilation rate were recorded at 45 and 60 days after sowing (DAS). Net assimilation rate was assessed following the method of Milthorpe and Moorby (1988). The biochemical parameters, viz. carbonic anhydrase activity (Dwivedi and Randhawa 1974), nitrate reductase activity (Jaworski 1971) and the contents of leaf nitrogen (Lindner 1944), phosphorus (Fiske and Subba Row 1925) and potassium (determined flame photometrically) were estimated at these two stages. At maturity, data for various yield components (pods per plant, seeds per pod, 1000-seed weight, seed yield, oil content and oil yield) as well as fatty acid content of oil were recorded. Oil was extracted with the help of Soxhlet apparatus using petroleum ether as solvent. Oil yield was computed on the basis of seed yield and oil percentage. Fatty acid composition was determined following the method of Chalvardjian (1964).

RESULTS AND DISCUSSION

The perusal of data establishes that significant differences exist among the cultivars in term of all the parameters studied (Tables 1-4). At both the stages, cultivars Kranti, Rohini and TERI (0E) M21-Swarna (being at par) produced the tallest plants. On the other hand, Pusa Gaurav exhibited the lowest plant height. Leaf number was highest in Rohini which showed parity with TERI (0E) M21-Swarna. Leaf area index was highest in Hyola PAC-401 and lowest in Kranti. Hyola PAC-401

Table1. Evaluation of rapeseed- mustard cultivars for growth parameters.

Characteristics	DAS	Cultivars							
		Hyola PAC-401	IGC-01	Jagannath	Kranti	Pusa Gaurav	Rohini	TERI(0E) M21-Swarna	CD at 5%
Shoot length	45	89.5	99.1	92.7	125.0	82.7	126.7	130.0	10.33
(cm/plant)	60	118.7	103.7	115.8	141.7	90.3	152.3	144.3	16.37
Leaf number	45	21.3	20.7	22.3	19.7	19.0	25.7	24.7	3.10
(per plant)	60	31.3	27.7	29.0	28.7	31.0	35.3	37.7	4.27
Leaf area	45	5.81	3.76	3.79	3.73	3.73	4.56	4.60	0.20
index	60	6.16	3.88	4.20	3.82	3.86	4.90	4.88	0.02
Fresh weight	45	136.4	127.4	171.4	238.0	171.2	148.7	246.6	24.18
(g/plant)	60	355.5	179.0	148.5	243.8	246.7	314.4	301.5	38.17
Dry weight	45	23.1	21.6	18.7	18.9	18.4	24.8	25.2	4.85
(g/plant)	60	35.3	34.0	32.2	28.9	30.7	39.5	35.1	6.24
Net assimilation rate (g/m^2 leaf area / day)	45 – 60	1.12	0.96	1.00	0.83	0.95	1.66	1.05	0.13

Table2. Evaluation of rapeseed-mustard cultivars for physiological parameters.

Parameters	DAS	Cultivars							CD at 5%
		Hyola PAC-401	IGC-01	Jagannath	Kranti	Pusa Gaurav	Rohini	TERI(0E) M21-Swarna	
Carbonic ahydrase activity	45	188.2	172.2	166.2	170.2	171.3	177.3	180.3	4.33
(μ mol CO_2/ kg leaf f. m./s)	60	228.3	187.3	177.1	174.4	180.0	195.1	200.0	8.00
Nitrate reductase activity	45	292.2	265.2	264.3	261.5	264.8	279.7	290.1	0.09
(n mol NO_2 / h /g leaf f. m.)	60	322.5	308.6	301.8	302.6	302.7	309.2	314.6	0.09
N content (%)	45	4.95	4.44	4.24	4.19	4.27	4.44	4.43	0.19
	60	3.88	3.56	3 .56	3.62	3.50	3.64	3.66	0.19
P content (%)	45	0.44	0.44	0.43	0.42	0.44	0.46	0.45	0.02
	60	0.35	0. 34	0.34	0.33	0.34	0. 34	0.34	0.01
K content (%)	45	4.75	4.45	4.38	4.28	4.54	4.75	4.68	0.17
	60	3.93	3.78	3.81	3.73	3.85	4.07	3.82	0.18

Table3. Yield and yield components of rapeseed-mustard cultivars.

Characteristics	Cultivars							CD at 5%
	Hyola PAC-401	IGC-01	Jagannath	Kranti	Pusa Gaurav	Rohini	TERI(0E) M21-Swarna	
No. of Pods per plant	487.3	289.0	242.7	260.0	282.3	388.3	396.3	14.12
No. of Seeds per pod	30.9	13.6	14.2	13.5	14.4	14.6	15.4	2.53
1000 – seed weight (g)	3.62	3.50	3.69	3.21	3.62	3.73	3.95	0.36
Seed yield (kg / ha)	1581.2	1354.1	1290.2	1303.4	1363.7	1431.0	1499.5	64.51
Oil content (%)	37.0	39.2	38.7	34.8	40.0	39.2	38.1	3.35
Oil yield (kg /ha)	586.2	531.1	499.3	452.5	545.1	560.7	570.2	14.92

Table 4. Fatty acids composition of oil (%) in of rapeseed-mustard cultivars.

Fatty acids	Cultivars							CD at 5%
	Hyola PAC-401	IGC-01	Jagannath	Kranti	Pusa Gaurav	Rohini	TERI(0E) M21-Swarna	
Palmitic (16: 0)	4.76	4.72	4.92	5.00	5.60	5.63	4.51	0.02
Stearic (18: 0)	1.71	1.42	1.36	1.32	1.49	1.53	1.66	0.05
Oleic (18: 1)	16.74	34.95	21.24	18.26	35.25	21.72	41.75	0.06
Linoleic (18: 2)	34.46	17.65	16.18	18.35	15.28	14.45	38.73	0.40
Linolenic (18: 3)	8.84	22.16	22.76	10.65	19.56	10.35	10.34	0.41
Erucic (22: 1)	0.18	47.41	35.04	48.30	45.30	43.37	0.25	0.33

produced highest fresh and dry matter. However, its dry weight was at par with that of Rohini, TERI (0E) M21-Swarna and IGC-01. The cultivars IGC-01 and Kranti showed the lowest value for fresh weight and dry weight, respectively. The net assimilation rate of Hyola PAC-401 occupied the second position after Rohini while cultivar Kranti exhibited the lowest rate (Table 1).

The activities of leaf carbonic anhydrase and nitrate reductase at both stages were found to be highest in Hyola PAC-401, whereas Kranti showed the lowest activities. Leaf NPK content were also highest in Hyola PAC-401 and lowest in Kranti in most samplings (Table 2).

Yield attributes, like pods per plant, seeds per pod, seed yield, oil content and oil yield, were found to be highest in Hyola PAC-401, but 1000-seed weight was highest in TERI (0E) M21-Swarna. Kranti gave poor performance for most parameters. The superlative performance of Hyola PAC-401, for example, may be gauged from the fact that it gave 21% and 29.69 % higher seed and oil yield respectively than Kranti (Table 3).

Fatty acid composition of oil indicated highest palmitic acid (C 16:0) content in Rohini (Table 4). This variety was followed by Pusa Gaurav. The lowest content of this fatty acid was found in TERI (0E) M21-Swarna. Stearic (C 18:0) and oleic (C 18:1) acid content was highest in Hyola PAC-401 and lowest in Kranti. The highest content of linoleic acid (C 18:2) was present in TERI (0E) M21-Swarna, followed by that in Hyola PAC-401. Rohini exhibited the lowest content of linoleic acid. Jagannath, followed by IGC-01, contained the highest content of linolenic acid (C 18:3). On the other hand, Hyola PAC-401 had the lowest percentage of this fatty acid. The highest erucic acid (C 22:1) content was found in Kranti which was followed by IGC-01. Again, the lowest content of this undesirable fatty acid (0.18%) was found in Hyola PAC-401, which showed parity with TERI (0E) M21-Swarna.

The data (Tables 1-4) reveal that the cultivars selected for the present trial showed significant differences with regard to one or the other parameter studied. The observation could be ascribed to the variation in their genetic potential. Similar results are reported by Mohammad *et al*.(1984), Kunelius and Sanderson (1990), Aly *et al*. (1999) and Tahoun *et al*. (1999) in other cultivars of rapeseed-mustard. The superior dry weight of Hyola PAC-401, Rohini, TERI (0E) M21-Swarna and IGC-01 at both stages seems to be the cumulative effect of various growth parameters. In addition, the activities of carbonic anhydrase and nitrate reductase were highest in Hyola PAC-401 (Tables 1 and 2), which clearly indicate efficient photosynthesis and nitrogen metabolism, respectively. The higher values for net assimilation rate and leaf nitrogen content in this variety further support the above proposition. The contributing factors for these observations could be its superior growth parameters, including (1) height which ensures better exposure of leaves and (2) greater leaf area which is responsible for efficient harvesting of the incident radiant energy. Thus, the availability of sufficient amounts of nutrients (particularly phosphorus) and photosynthates would result in their better partitioning as is clear from the higher values of various yield attributes, including pods per plant and seeds per pod. The highest seed and oil yield in Hyola PAC-401 (Table 3) was not unexpected as the values for various physiological and yield parameters were high in this variety of rapeseed.

The fatty acid composition of oil of the selected cultivars (Table 4) substantiates the superiority of Hyola PAC-401, followed by TERI (0E) M21—Swarna as these had higher content of oleic acid and lower percentage of linolenic acid and erucic acid, and the similar pattern of fatty acid composition of oil is considered good for human consumption. Therefore, in view of their superior yielding ability, coupled with negligible erucic acid content (0.18% in Hyola PAC-401 and 0.25% in TERI (0E) M21-Swarna), these two cultivars are considered best for large scale cultivation and consumption.

ACKNOWLEDGEMENT

Authors are grateful to the National Research Centre on Rapeseed-Mustard, Bharatpur, for supplying authentic seeds of Hyola PAC-401 (*Brassica napus*) and TERI (0E) M21-Swarna (*Brassica juncea*) and to the Aligarh Muslim University, Aligarh for extending research facilities.

REFERENCES

Aly, A. E., Ghazy, A. H. I. and Taoun, M. K. (1999). The influence of *Brassica* species and accession on productivity and nutrient quality of forage rape in Egypt. *Proceeding of 10th International Rapeseed Congress*, Canberra, Australia.

Chalvardjian, A.M. (1964). Fatty acids of brown and yellow fat in rats. *Biochem. J.* **90:** 518-521.

Dwivedi, R.S. and Randhawa, N.S. (1974). Evaluation of rapid test for hidden hunger of zinc in plants. *Plant Soil*. **40:** 445-451.

Fiske, C.H. and Subba Rao, Y. (1925). The colorimetric determination of phosphorus**.** *J. Biol. Chem.* **66:** 375-400.

Jaworski, E.G. (1971). Nitrate reductase assay in intact plant tissue. *Biophys. Res. Comm.* **43:** 1274-1279.

Kunelius, H.T. and Sanderson, J.B. (1990). Effect of harvest dates on yield and composition of forage rape, stubble turnip, and forage radish. *App. Agric. Res.* (USA), **5**: 159-163.

Lindner, R.C. (1944). Rapid analytical methods for some of the more common inorganic constituents of plant tissue. *Plant Physiol*.**19:** 76-89.

Milthorpe, F.L. and Moorby, J. (1979). An Introduction to Crop Physiology. 2nd Ed. Cambridge University Press, Cambridge.

Mohammad F., Samiullah and Afridi, M.M.R.K. (1984). Comparative performance of ten mustard varieties in relation to yield and quality. *Geobios*, **11:** 92-93.

Tahoun, M. K., Ghazy, A.H.I. and Aly, A. E. (1999). Oil and erucic acid contents of five *Brassica* species grown for four successive years in Egypt. *Proceedings of 10th International Rapeseed Congress,* Canberra, Australia.