Journal of Pharmacognosy and Phytochemistry 2018; 7(1): 808-810

Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2018; 7(1): 808-810
Received: 11-11-2017
Accepted: 12-12-2017

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Effect of sowing environments and nitrogen levels on light interception and its efficiency in dry matter production in Indian mustard (*Brassica juncea*)

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Abstract
Field experiments were conducted at the experimental farm of Chaudhary Charan Singh Agricultural University, Hisar, Haryana (latitude 29^0 10' N and longitude 75^0 36' E Latitude) during *rabi* season of two years (2013-14 and 2014-15). The experiment was laid out in split plot design with three replications consisted four dates of sowing as main plots and five nitrogen levels as sub plot treatments. The Indian mustard variety RH 0749 was selected. The growth parameters were measured at 30, 60, 90, 120 DAS and at maturity stage. The growth parameters LAI, total dry matter/plant, and CGR progressively got decreased with delay in sowing. Among the nitrogen levels, 100 kg N/ha recorded highest growth parameters significantly. Absorbed PAR in mustard found decreased with delay in sowing. Mustard fertilized with 100 kg N/ha absorbs maximum PAR. Delay in sowing adversely affected the radiation use efficiency of mustard crop. The radiation use efficiency varied between1.74 to 2.18 (2013-14) and 1.67 to2.04 g/MJ (2014-15). Radiation use efficiency explained around 77 and 94 per cent variability in leaf area index and total dry matter of mustard crop.

Keywords: date of sowing, nitrogen levels, mustard, radiation use efficiency and photosynthetic active radiation

Introduction
Rapeseed-mustard (*Brassica spp*.) is a major group of oilseed crops of the world with second largest acreage in India after China. Indian mustard (*Brassica juncea* L.) has been reported to tolerate annual temperature of 6 to 27°C and can be grown on soils with pH of 4.3 to 8.3. Solar radiation is the main source of energy for photosynthesis, the initial process that green plants use to convert carbon dioxide and water into simple sugars. Other plant processes convert these initial products of photosynthesis into dry matter. Photosynthetically active radiation (PAR) is the radiation in the particular waveband which excites chlorophyll molecules and other pigments and thus initiates the flow of energy required in photosynthesis. The ratio of PAR to total solar energy received at the surface is generally reported to be about 0.49 (Kailasnathan and Sinha, 1984) [3]. When a healthy crop receives adequate water and nutrients, dry matter production is mainly governed by solar energy available for photosynthesis.

Radiation use efficiency refers to the efficiency with which intercepted radiation energy is used for the production of biomass. Radiation interception depends mainly on the leaf area index (LAI) and canopy architecture. Dhaliwal and Hundal (2004) [2] found that the solar radiation interception was maximum at 90 days after sowing when peak leaf area index occurred, and there was a positive correlation coefficient of IPAR with leaf area-index (r=0.87) and dry matter (r=0.80). Nehra *et al*. (1996) [5] reported that delay in sowing of toria (*Brassica campestris*) from first week of September to first week of October significantly increased the radiation use efficiency. RUE is the value of the slope of the linear relationship between biomass production and IPAR (Sinclair and Muchow, 1999) [9]. Higher light interception was reported by Kler *et al.* (1983) [4] in bi-directional sowing of gram crop. Therefore, an attempt was made to study the PAR interception and its efficiency in dry matter production in mustard under different nitrogen levels and sowing environments.

Materials and Methods
The field experiment was conducted during *rabi* season of 2013-14 and 2014-15 at the research farm of the Department of Agronomy, CCS Haryana Agricultural University, Hisar (latitude: 29º10'N, longitude 75º46' E and altitude 215.2 m). The soil of the experimental field was sandy loam, having 0.57% organic carbon and pH 8.73.

It was low in available N (155 kg ha^{-1}), medium in available P_2O_5 (23.2 kg ha^{-1}) and rich in available K_2O (395.6 kg ha^{-1}). The experiment consisting of four dates of sowing Oct 15th & 25th and Nov 5th & 15th in main plots and five nitrogen levels (0 kg N ha^{-1} (Control), 40 kg ha^{-1}, 60 kg N ha^{-1}, 80 kg N ha^{-1} and 100 kg N ha^{-1}) in sub plots was laid out in split plot design with three replications. All other agronomic practices were followed as per package of practices recommended for Indian mustard crop by the University. The leaf area was measured with leaf area meter (Licor-3100) at an interval of 30 days starting from 30 days after sowing onwards to physiological maturity. The plant samples taken for leaf area measurement were dried in oven at 65±5ºC temperature till constant weight and weighed on an electric balance. The final seed yield was recorded after threshing the samples from all plots.

Line quantum sensor (LI-190 SB) was used to measure the photosynthetically active radiation (PAR) in the range of 400 to 700 nm at canopy level. The reflected radiation was obtained by keeping the sensor inverted above the canopy and the sensor was also kept on ground across the rows diagonally to get transmitted radiation to the ground. The observations were recorded at different growth stages during 11:30-13:00 hours on clear days.

Daily Solar radiation was computed by the expression

$$R_s = Ra\ (1-r)\ (a+b\ (n/N))$$

Where,

R_s is solar radiation received at the surface of the earth (cal/cm^2), Ra is solar radiation received outside the atmosphere (cal/cm^2) used from Smithsonian tables corresponding to the latitude values of Hisar, r is reflection coefficient (0.25) for green vegetations, a and b are constants, a=0.256; b=0.56 for Hisar, n=Bright sunshine hours/day, N=maximum possible hours of sunshine (Bishnoi *et al*., 1995) [1]

Daily PAR was calculated by the formula:

$$PAR = R_s \times 0.48$$ (Oleson *et al*., 2000) [6]

The PAR values were converted into MJ/m^2. The daily iPAR was calculated using the following expression:

$$IPAR = PAR\ (1-e^{-kf})$$ (Rosenthal and Gerik, 1991) [8].

Where,

K is extinction coefficient = 1n $(I-I_0)/f$

F is cumulative leaf area index of foliage layer,

I_0 is radiation energy at the top of the canopy

I is radiant energy at a level inside the crop canopy.

The radiation use efficiency (RUE) was calculated as:

$$RUE\ (g/MJ) = \Sigma DM\ (g/m2) / \Sigma IPAR\ (MJ/m2)$$

Where,

ΣDM = Cumulative dry matter for a growth period.

ΣIPAR = Cumulative intercepted phosynthetically active radiations for the same growth period.

The correlation and regression analysis were carried out to study the relationship of growth and yield with radiation use efficiency.

Results and Discussion

The radiation use efficiency (RUE) of Indian mustard under various treatments are presented in Table 1 during 2013-14 and 2014-15. The radiation use efficiency of Indian mustard increased with growing period and attained maximum at 90 DAS and afterward decreased till harvest in all the treatments and in both seasons. The mustard crop sown on 15th October was most efficient in radiation utilization in comparison with sown crop on October 25, 5th and 15th of November during both the years. This was attributed to maximum PAR interception by first mustard sown crop. The decrease in RUE with delay in sowing of wheat was reported by Ramniwas *et al*., (2006). The values increased with increase in nitrogen application in mustard crop. The maximum values of RUE were 1.74, 2.07, 2.11, 2.16 and 2.18 g/MJ in 0, 40, 60 80 and 100 kg N/ha respectively during 2013-14. The corresponding values of RUE for the second season were 1.67, 1.89, 2.01, 2.01 and 2.04, respectively. The IPAR and radiation use efficiency were correlated with leaf area index, dry matter and yield. The correlation coefficients 'r' was higher in case of RUE in comparison with intercepted PAR (Table 2). The simple regression model for leaf area index and dry mater based on RUE during maximum leaf area stage are depicted in Fig 1 and 2.

$$LAI = -2.748 + 3.322\ RUE$$
$$R^2 = 0.77$$
$$TDM = -24.32 + 33.37\ RUE$$
$$R^2 = 0.95$$

Where,

LAI = Leaf area index

TDM = Total dry matter (g/m2)

RUE = Radiation use efficiency (g/MJ)

The radiation use efficiency during maximum leaf area stage of mustard explained the variability upto 77and 95per cent in leaf area index and total dry matter production respectively.

Table 1: Effect of sowing time and Nitrogen levels on radiation use efficiency (g/MJ) of Indian mustard

Treatments	Days after sowing									
	30		60		90		120		At maturity	
	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15	2013-14	2014-15
Time of sowing										
Oct 15	0.96	0.87	1.17	1.13	2.27	2.18	2.08	2.00	1.99	1.88
Oct 25	0.79	0.68	1.27	1.22	2.18	2.11	1.98	1.89	1.81	1.72
Nov 5	0.75	0.64	0.93	0.88	2.03	1.80	1.93	1.80	1.71	1.59
Nov15	0.59	0.53	0.65	0.59	1.90	1.76	1.81	1.74	1.56	1.52
Mean	0.78	0.68	1.01	0.96	2.09	1.96	1.95	1.86	1.77	1.68
SD±	0.15	0.14	0.28	0.28	0.16	0.21	0.12	0.11	0.18	0.16
Cv (%)	19.5	20.9	27.6	29.4	7.79	11	5.92	5.94	10.1	9.34
Nitrogen levels (kg/ha)										
0 kg N/ha	0.88	0.70	1.03	0.85	1.74	1.67	1.71	1.60	1.60	1.57

40 kg N/ha	1.02	0.83	1.45	1.27	2.07	1.89	1.77	1.67	1.72	1.64
60 kg N/ha	1.04	0.88	1.56	1.42	2.11	2.01	1.80	1.72	1.77	1.70
80 kg N/ha	1.10	0.98	1.63	1.48	2.16	2.01	1.81	1.74	1.78	1.67
100 kg N/ha	1.11	1.03	2.08	1.84	2.18	2.04	1.85	1.78	1.80	1.68
Mean	1.03	0.88	1.55	1.37	2.05	1.92	1.79	1.70	1.74	1.65
SD±	0.09	0.13	0.38	0.36	0.18	0.15	0.05	0.07	0.08	0.05
Cv (%)	9.18	14.7	24.2	26.3	8.74	8.04	2.85	4.00	4.62	3.06

Table 2: Correlation coefficient (r) between Radiation use efficiency and Growth parameters

	RUE	**LAI at maturity**	**Dry matter at maturity**	**Seed yield**
RUE	1			
LAI at maturity	0.94	1		
Dry matter at maturity	0.93	0.96	1	
Seed yield	0.96	0.92	0.92	1

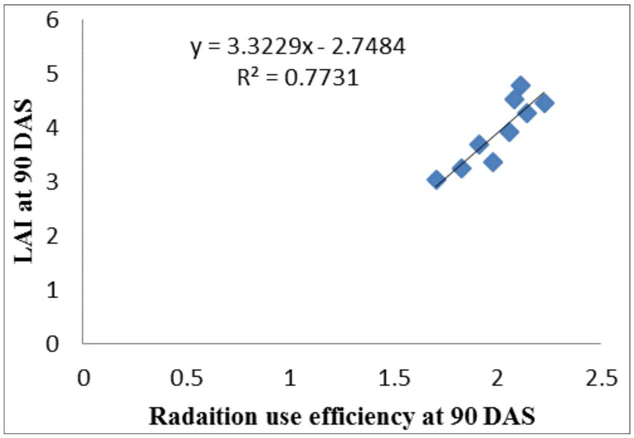

Fig 1: Radiation use efficiency and Leaf area index relationship in mustard

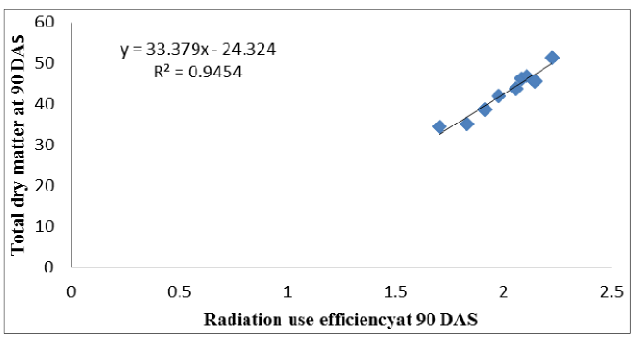

Fig 2: Radiation use efficiency and Total dry matter relationship in mustard

Conclusion

The study of this research indicated that optimum date of sowing and increased nitrogen levels leads to improved leaf area index, increased light interception accumulated dry matter and radiation use efficiency and can be used as reasonable management device to increase seed yield. The radiation use efficiency influences production of leaf area and dry matter and a close relationship exists between RUE and LAI and dry matter. There is an immense scope of using the radiation pattern and its balance as inputs of crop growth and yield prediction model.

References

1. Bishnoi OP, Singh S, Niwas R. Effect of temperature on phenological development of wheat. Indian J Agric. Sci. 1995; 63:211-214.
2. Daliwal LK, Hundal SS. Growth dynamics and radiation interception in Indian mustard (*Brasssica Juncea*). Indian J Agric. Sci. 2004; 74(6):321-323.
3. Kailasanthan K. Sinha SK. Radiation, productivity potential and actual biological yield at Delhi. Proc. Indian Nat. Sci. Acad. B. 1984; 46(5):688-693.
4. Kler DS. Bains DS. Relationship among plant height, chlorophyll content, leaf area index and grain yield of durum wheat under different sowing patterns. Haryana J. Agron. 1989; 5(2):87-92.
5. Nehra DS, Singh R, Ram Niwas, Bisnoi OP. Effect of temperature on radiation use efficiency on Toria (*Brassica campestris* var. Toria) crop. Annals of Arid Zone. 1996; 35(2):121-124.
6. Oleson JE, Jorgenson LN, Mortensen JV. Irrigation strategy, nitrogen application and fungicide control in winter wheat on a sandy soil. *II.* Radiation interception and conversation. J Agril. Sci., Cambridge. 2000; 134:13-23.
7. Ramniwas, Singh M, Khichar ML. Effect of sowing environment and nitrogen levels on light interception and its efficiency in dry matter production in wheat cultivars. Ann. Agric. Res. New Series. 2006; 27(3):271-276.
8. Rosenthal WD, Gerik, TJ. Radiation use efficiency among cotton cultivars. Agron. J. 1991; 83:655-658.
9. Sinclair TR, Muchow RC. Radiation use efficiency. Advances in Agronomy. 1999; 65:215-265.