RNI No. ORI ENG / 2003 / 15643 / 22.11.2005

ISSN No. 0974 - 4398 / 2008

ORGANISATION FOR PROTECTION OF ECOSYSTEM • ENVIRONMENT AND ENDANGERED SPECIES

e-planet

Volume - 12 | July - 2014 | Issue No. - 2

A multi-disciplinary International Journal of Ecology, Environment, Agriculture and Allied Sciences

e-planet **12** (2): 20-24 (July 2014)

Studies on phenology, oil and protein yield along with carbon sequestration of oilseed *Brassicas* under irrigated conditions

P.K. PANDA[1*], S.C. VARMA[2], H.C. SHARMA[2] AND S.N. SHARMA[2]

[1]*Directorate of Water Management, Bhubaneswar, Odisha - 751 023, India*
[2]*Banaras Hindu University, Varanasi, Uttar Pradesh -221005, India*
**pandaicar@gmail.com*

ABSTRACT

Due to population increase, the oil requirements have gone up in India and to meet the domestic requirements each year we are importing 8.43 million tones edible oil from other countries paying huge foreign exchange to the tune of Rs. 46,242 crores. The average productivity of the crops is only 750 kg ha^{-1} in eastern Uttar Pradesh compared to national average of 1145 kg ha^{-1} and global average of 1950 kg ha^{-1}. The highest productivity of the crop is however recorded by UK (3,322 kg ha^{-1}). In the main plots six combinations of N, P, K and S (F_1- N_{40} $P_{20}K_{20}S_0$, F_2- N_{40} $P_{20}K_{20}S_{40}$, F_3- N_{80} $P_{40}K_{40}S_0$, F_4- N_{80} $P_{40}K_{40}S_{40}$, F_5- N_{120} $P_{60}K_{60}S_0$ and F_6- N_{120} $P_{60}K_{60}S_{40}$) were taken and in sub plots four brassica species (*B. Juncea* var Pusa Jaikissan, *B. napus* var Hyola-401, *B. Carinata* var Kiran Rai and *B. campestris* var YST-151) were grown. Among various brassica species, Kiran Rai (*Brassica carinata*) produced a seed yield of 18.90 q ha^{-1} with the treatment N_{120} $P_{60}K_{60}S_{40}$ and at the same nutrient levels Pusa Jaikissan (*Brassica juncea*) produced a seed yield of 16.56 q ha^{-1} after harvest of *kharif* rice.

Key words : Oil and protein yield, carbon sequestration, oilseed *Brassicas*.

INTRODUCTION

Due to population increase, the oil requirements have gone up in India and to meet the domestic requirements each year we are importing 8.43 million tones edible oil from other countries paying huge foreign exchange to the tune of Rs. 46,242 crores (Anonymous, 2012). Rapeseed mustard groups or oil seed *Brassicas* are one of the important oil seed crops of India, occupying a cultivated area of 5.92 million hectares with a total production of 6.78 million tons (Anonymous, 2012). The average productivity of the crops is only 750kg ha^{-1} in eastern Uttar Pradesh compared to national figure of 1,145 kg ha^{-1} and global average of 1,950 kg ha^{-1}. The highest productivity of the crop is however recorded by UK (3322 kg ha^{-1}). Hence, there is a scope to enhance the production and productivity by identifying suitable genotypes with required agro techniques. An attempts was made to evaluate four *Brassica* species for getting higher oil yield with optimum application of the major nutrients such as nitrogen, phosphorus, potassium, sulphur and irrigation with scientific plant protection measures. If the production and productivity of rape seed mustard is increased, it would definitely reduce the import bill.

MATERIALS AND METHODS

The experiment was conducted in the research farm of Institute of Agricultural sciences, BHU, Varanasi (25^o 18' N latitude, 83^o 03' E longitude and an altitude of 75.7 meter above mean sea level) for two consecutive years under split plot design with three replications. The soil of the experimental site was sandy clay loam with 7.4 pH and 0.38% organic carbon. The available N, P, K and S were 208.7, 15.8, 177.3 an 18.82 kg of N, P_20_5, K_20 and S per hectare, respectively. The main plot treatments comprised of six combinations of N, P, K and S (F_1- N_{40} $P_{20}K_{20}S_0$, F_2- N_{40} $P_{20}K_{20}S_{40}$, F_3- N_{80} $P_{40}K_{40}S_0$,

F_4- N_{80} $P_{40}K_{40}S_{40}$, F_5- N_{120} $P_{60}K_{60}S_0$ and F_6- N_{120} $P_{60}K_{60}S_{40}$ and in sub plots four brassica species (*B. Juncea* var Pusa Jaikissan, *B. napus* var Hyola-401, *B. Carinata* var Kiran Rai and *B. campestris* var YST-151) were assigned. The row to row and plant to plant spacing was kept as 45 cm and 15 cm, respectively. Recommended agro techniques were followed under irrigated condition to access the yield and other parameters. All chemical analysis was done following standard procedure (Jackson, 1973). The statistical analysis was done as per scientific procedure(Gomez and Gomez, 1984). Following formulas were used for calculating various parameters under study.

Growing degree days (GDD)

Growing degree days, also called as heat units, effective heat units or growth units indicates relationship of plant growth, development and maturity to air temperature is calculated using following equation.

$$GDD = \sum_{i=1}^{n} \left(\frac{T_i + t_i}{2} - T_b \right)$$

Where T_i and t_i are the maximum and minimum air temperature in degree Celsius (°C) on i^{th} day and T_b is the base temperature or threshold temperature (Chakraborty *et al.,* 1994). 5 °C is used as base temperature for computing growing degree days of mustard (Niwas *et al.*, 1990 and Singh *et al.,* 1995).

Photo-thermal units (PTU)

It was computed as per the following formulae:

$$PTU = \sum_{i=1}^{n} GDD \times BSH$$

where BSH = Bright sunshine hours (hours/day)

Oil yield(q/ha) = Seed yield(q/ha) X oil content(%)

Protein yield (q/ha) = Seed yield (q/ha) × protein content (%)

Above ground carbon storage (AGCS-ton/ha) = Stover yield (t/ha) × 0.5 (Anon.,2001)

CO_2 sequestration by the stover (ton/ha) = AGCS X 3.67 (Anon., 2003)

RESULTS AND DISCUSSION

Growing degree days required for attaining 50% flowering and physiological maturity as affected by various treatments are presented in table1. Scrutiny of the data revealed that GDD requirement increased significantly with progressive increase in rate of NPK from N_{40} $P_{20}K_{20}$ to N_{120} $P_{60}K_{60}$ for attaining 50% flowering and physiological maturity and sulphur application reduced it slightly. Early acquisition GDD may result in early occurrence of 50% flowering in the first year. Delayed sowing exposed to lower temperature and hence increased GDD requirement in second year. Brassica species differed considerably among themselves with respect to occurrence of 50% flowering and physiological maturity mainly due to variation in GDD requirements (Singh *et al.,* 1995). PTU requirement for 50% flowering and physiological maturity increased with increase in doses of nitrogen, phosphorus and potassium and sulphur application reduced it in both the years. Availability of higher quantity of major nutrient like NPK might have triggered growth better by supporting higher photosynthesis for longer duration and hence recorded higher values. During winter season little delayed sowing in second year registered relatively lower PTU both at 50% flowering and physiological maturity due to lower sunshine duration. Brassica species exhibited differential behavior due to genetic nature of the individual. Individual figures can be seen from the table. Interaction effect of different experimental variables proved ineffective during both the years.

Seed, oil and protein yield along with above ground carbon sequestration as influenced by various treatments are presented in Table 2. In general, seed, oil and protein yield and above ground carbon sequestration significantly increase with increase of NPK dose from N_{40} $P_{20}K_{20}$ to N_{120} $P_{60}K_{60.}$ Application of sulphur to respective dose of NPK also significantly increase seed, oil, protein yield and above ground carbon sequestration. Highest seed, oil, protein and carbon sequestration

Table 1. Effects of N,P, K and S applications on GDD and PTU required for attaining 50% flowering and physiological maturity

Treatments	First year				Second year			
	GDD		PTU (× 10^3)		GDD		PTU (× 10^3)	
	50% flowering	Physio-logical maturity	50% flowering	Physio-logical maturity	50% flowering	Physio-logical maturity	50% flowering	Physio-logical maturity
Fertility status and S								
$N_{40}P_{20}K_{20}S_0$ (F_1)	892	1648	7.21	13.41	894	1668	5.76	11.86
$N_{40}P_{20}K_{20}S_{40}$ (F_2)	887	1641	7.2	13.35	885	1662	5.71	11.8
$N_{80}P_{40}K_{40}S_0$ (F_3)	908	1751	7.31	14.3	920	1737	5.91	12.46
$N_{80}P_{40}K_{40}S_{40}$ (F_4)	903	1744	7.29	14.24	916	1736	5.87	12.43
$N_{120}P_{60}K_{60}S_0$ (F_5)	923	1825	7.4	14.9	933	1817	5.98	13.08
$N_{120}P_{60}K_{60}S_{40}$ (F_6)	915	1818	7.36	14.85	923	1812	5.95	13.03
CD (P=0.05)	5.34	10.5	0.04	0.11	9.8	12.18	0.05	0.08
Brassica species								
PusaJaikisan (V_1)	769	1559	6.27	12.7	737	1575	4.81	11.04
Hyola-401 (V_2)	823	1599	6.52	13.03	810	1612	5.01	11.32
KiranRai (V_3)	1206	2288	9.85	18.72	1298	2246	8.65	16.82
YST-151 (V_4)	819	1505	6.5	12.25	800	1522	4.99	10.6
CD (P=0.05)	5.12	7.81	0.04	0.07	5.93	7.6	0.03	0.06
Interaction (Ax B)	NS	NS	NS	NS	NS	NS	NS	NS

yield of 18.90 q ha^{-1}, 7.45 q ha^{-1}, 3.90 q ha^{-1} and 9.8 ton ha^{-1} were recorded by $N_{120}P_{60}K_{60}S_{40}$ during first year. This may be attributed to the availability of optimum quantity of N, P, K and S for plant growth and translocation of photosynthates towards reproductive sink i.e. seed. Under higher dose of N, P and K application, rapid conversion of carbohydrate to protein is expected and hence protein content is also increased. In case of oilseed *Brassicas*, sulphur is required for formation of glucosides. Higher glucosides on hydrolysis might have produced higher amount of oil. These are in agreement with the finding of Kachoo and Kumar (1999) and Sarmah and Debnath (1999). Among the brassica species, Kiaran Rai produced significantly higher seed yield (17.16 q ha^{-1}), oil yield (6.84 q ha^{-1}), protein yield 3.45 q ha^{-1}) and above ground carbon sequestration (9.94 t ha^{-1}) compared to other varieties in first year which found to be higher to second year with similar trend. This is due to higher vegetative and reproductive infrastructure of Kiran Rai with relatively longer duration which resulted in production of higher quantities of photosynthates and translocation of the same to the reproductive sink i.e. seed. The above findings are in accordance with the earlier findings of Kachroo and Kuwar (1999) and Tharkral *et al.* (1999).

CONCLUSION

Under irrigated conditions of Varanasi, a seed yield of 18.90 q ha^{-1} can be produced by Kiran Rai of *Brassica carinata* with application of N_{120}

Table 2. Effects of N, P, K and S applications on seed, oil and protein yeild and carbondioxide sequestration

Treatments	First year					Second year				
	Seed yield (q ha^{-1})	Stover yield (q ha^{-1})	Oil yield (q ha^{-1})	Protein yield (q ha^{-1})	CO_2 Sequest-ration (ton ha^{-1})	Seed yield (q ha^{-1})	Stover yield (q ha^{-1})	Oil yield (q ha^{-1})	Protein yield (q ha^{-1})	CO_2 Sequest-ration (ton ha^{-1})
Fertility status and S										
N_{40} $P_{20}K_{20}S_0$-F_1	11.43	39.35	4.65	2.29	7.22	10.84	35.84	4.39	18.95	6.58
N_{40} $P_{20}K_{20}S_{40}$-F_2	12.76	42.43	5.25	2.55	7.79	12.29	39.39	5.03	19.08	7.23
N_{80} $P_{40}K_{40}S_0$-F_3	15.55	49.63	6.2	3.06	9.11	14.65	44.23	5.82	19.44	8.12
N_{80} $P_{40}K_{40}S_{40}$-F_4	16.6	51.17	6.69	3.29	9.39	15.82	46.37	6.36	19.62	8.51
N_{120} $P_{60}K_{60}S_0$-F_5	17.65	51.71	6.88	3.63	9.49	16.56	46.7	6.41	20.23	8.57
N_{120} $P_{60}K_{60}S_{40}$-F_6	18.9	53.5	7.45	3.9	9.82	17.72	48.41	6.97	20.47	8.89
CD (P=0.05)	0.33	1.22	0.17	0.18		0.31	0.66	0.12	0.13	
Brassica species										
PusaJaikisan -V_1 *(Brassica juncea)*	16.56	49.19	6.72	3.27	9.03	15.77	45.05	6.38	19.13	8.27
Hyola-401 -V_2 *(Brassica napus)*	16.08	48.14	6.16	3.41	8.83	15.08	43.64	5.75	20.84	8.01
KiranRai -V_3 *(Brassica carinata)*	17.16	54.02	6.84	3.45	9.94	16.11	48.32	6.39	19.81	8.87
YST-151 -V_4 *(Brassica campestris)*	12.13	40.51	5.02	2.36	7.44	11.63	36.95	4.79	18.74	6.79
CD (P=0.05)	0.27	0.74	0.12	0.12		0.29	0.69	0.12	0.1	
Interaction (Ax B)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

$P_{60}K_{60}S_{40}$ per ha and at the same nutrient levels Pusa Jaikissan of *Brassica juncea* can produce a seed yield of 16.56 q ha^{-1} after harvest of *kharif* rice.

REFERENCES

Anonymous, 2001. Third assessment report of climate change by Intergovernmental panel on climate change (IPCC), Hayama, Japan.

Anonymous, 2003. Good practice guidance for land use, land use change and forestry (IPCC). Bypenman, J., Gytarsky, M., Hiraishi, T., Krug, T., Kruger, D., Pipatti, R., Buendia, L.M., Ngara, T., Tanabe, K. and Wagner, F. Intergovernmental panel on climate change (IPCC), IPCC/ IGES, Hayama, Japan.

Anonymous, 2012. Agricultural Statistics at a glance. Published by Directorate of Economics, and Statistics, Department of Agriculture and Cooperation, Ministry of Agriculture, Govt. of India, New Delhi.

Anonymous, 2012. Import of commodities. Director General of Commercial Intelligence and Statistics, Ministry of Commerce, Kolkata

Chakraborty, P.K., Nath, R. and Sounda, G. 1994. Effects of dates of sowing on the growing degree days, photothermal units and heliothermal unit requirement for different phenophases in sesame. *Journal of Oilseed Research* **11**(1): 40-43.

Gomez, K.A. and Gomez, A.A. 1984. Statistical procedures for agricultural research: An international rice research book, Manila, Philippines, published by John Wiley and Sons, Singapore.

Jackson, M.L. 1973. Soil chemical analysis practice hall of India Pvt. Ltd. New Delhi

Kachroo, D. and Kumar, A. 1999. Seed weight, oil and protein contents of Indian mustard (*Brassica juncea*) as influenced by nitrogen and sulphur fertilization. *Annals of Agriculture Research* **20**(3): 369-371.

Niwas, R., Rao, V. and Bisnoi, O.P. 1990. Heat unit requirements of *raya. Mausam* **41**(4): 637-638.

Sarmah, P.C. and Debnath, M.C. 1999. Response of toria (*Brassica campestris* subsp. Oleifera var. *toria*) to sources and levels of sulphur fertilization. *Indian Journal of Agronomy* **44**(3): 617-620.

Singh, R., Nehra, D.S., Singh, R. and Bisnoi, O.P. 1995. Heat unit efficiency in *toria* (*Brassica campestris*). *Journal of Oilseed Research* **12**(2): 268-270.

Thakral, S.K., Singh, B.P. and Faroda, A.S. 1999. Effect of irrigation and fertility levels on oil yield and quality of *Brassica* species. *Haryana Journal of Agronomy* **15**(1): 42-45.