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Effect of weed management and nitrogen nutrition on biochemical and phenological parameters of Indian mustard [*Brassica juncea* (L.) Czern and Coss.]

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Abstract
A field experiment carried out during the *rabi*, 2014-2015 in Rajasthan College of Agriculture, Udaipur to study the effect of weed management and nitrogen application on Indian mustard [*Brassica juncea* (L.) Czern and Coss.]. The experiment comprising 15 treatment combinations consisted of 5 weed management practices and 3 nitrogen levels and was evaluated under factorial randomized block design with three replications. The results show that pre-emergence application of oxadiargyl 0.09 kg ha^{-1} recorded seed and oil yield (2234 and 899 kg ha^{-1}) with the highest (2.67 mg g^{-1} of fresh leaves) chlorophyll content among different herbicidal treatments which was comparable to one hand weeding. Among the nitrogen levels, application of both 75 and 60 kg N ha^{-1} resulted in significant increase in chlorophyll content, seed and oil yield of plant over 45 kg N ha^{-1}.

Keywords: Indian mustard, pre-emergence, oxadiargyl, chlorophyll content and yield

Introduction
Among oilseeds, rapeseed and mustard is the second major oilseed crop after groundnut in India. Crop is severely infested both by monocot as well as dicot weeds especially under irrigated conditions and causes yield reduction to the tune of 68% (Degra *et al.*, 2011) [1]. This yield reduction is resulted from deprivation in nutrient uptake by the crop due to more competitive ability of weeds in using the nutrients available in soil than the crop. Nitrogen is an essential nutrient which has a synergistic effect in uptake of other nutrients. Nitrogen improve photosynthetic ability of crop by improving chlorophyll content in green part of the crop and it was also reported that abscissic acid (ABA) concentration in tissue is affected by nitrogen availability (Gawronska *et al.*, 2004) [3] and thus ultimately increase in crop duration which indirectly contributes to higher yield. Therefore, different nitrogen levels along with weed management practices were tested in Indian mustard to carry out the experiment.

Materials and Methods
A field experiment was conducted on clay loam soil of Instructional farm, Rajasthan College of Agriculture, MPUAT, Udaipur (582.17 m above mean sea level, 24°35´ N latitude and 73°42´ E longitude) Rajasthan. The soil of the experimental field was alkaline in reaction (pH 8.2), medium in available N (287.00 kg ha^{-1}) and P_2O_5 (20.51 kg ha^{-1}) and high in K_2O (286.88 kg ha^{-1}). The experiment laid out in randomized block design involving 15 treatment combinations consisted of 5 weed management practices (pendimethalin 0.75 kg ha^{-1} as pre emergence, oxadiargyl 0.09 kg ha^{-1} as pre emergence, quizalofop-ethyl 0.05 kg ha^{-1} 25 days after sowing (DAS), hand weeding 25 DAS and weedy check) and 3 nitrogen levels (45, 60 and 75 kg ha^{-1}). Indian mustard variety BIO-902 (*Pusa Jaikisan*) was sown with seed rate of 2.5 kg ha^{-1} on 2nd November, 2014 at 30 cm × 10 cm spacing using package of practices available for "Sub-Humid Southern Plain and Aravalli Hills" of Rajasthan. Herbicides were sprayed with knapsack sprayer fitted with flat fan nozzle using 500 litres of water per hectare. The required doses of N for different treatments were applied both through urea and DAP after adjusting the quantity of nitrogen supplied by DAP for supplying 35 kg ha^{-1} of phosphorus. Seed oil content and chlorophyll content were determined by following standard procedures. Oil yield (kg ha^{-1}) was calculated from seed yield (kg ha^{-1}) and seed oil content (%) by using the following expression.

$$\text{Oil yield} = \frac{\text{Oil content in seed X seed yield}}{100}$$

Result and Discussions

Effect on chlorophyll content and phonological parameters

Chlorophyll content of leaves of Indian mustard had been recorded significantly minimum under weedy check as compared to all weed management treatments as under unweeded condition crop was not able to compete for nutrients with weeds. Among different herbicidal treatments oxadiargyl 0.09 kg ha^{-1} recorded the highest (2.67 and 2.25 mg g^{-1} of fresh leaves at 60 and 90 DAS, respectively) chlorophyll content which was comparable to one hand weeding (Table 1.). The increase in chlorophyll content of the crop under weed management treatments can be clearly attributed to the reduction in interference of the weeds which ultimately favoured adequate availability of lights, temperature and space along with moisture and nutrients, improved physiological and morphological characters of plant as well as photosynthesis with greater rate ultimately leads to more chlorophyll content in plants (Duncan, 1971) [2]. On the other hand, among the three levels of nitrogen, application of both 75 and 60 kg N ha^{-1} resulted in significant increase in chlorophyll content of plant over 45 kg N ha^{-1} (2.48 and 2.08 mg g^{-1} of fresh leaves at 60 and 90 DAS, respectively). The per cent increase in chlorophyll content g^{-1} of fresh weight of leaves of the crop due to 75 kg N ha^{-1} was 12.50 and 9.62 as compared to 45 kg N ha^{-1}. Chlorophyll content of leaves improved significantly with increase in nitrogen levels seems to be due to the fact that nitrogen is a structural element of pyrrole rings of chlorophyll a & b and protein molecules. This in turn affects formation of chloroplast and accumulation of chlorophyll in them. This in turn affects formation of chloroplast and accumulation of chlorophyll in them. Rathor *et al.* (2014) [5] also found the higher chlorophyll content with increased N levels which confirm the result of the present experimentation. Addition of each level of nitrogen significantly increased days to maturity however, days to 50 % flowering was not affected due to nitrogen fertilization and resulted into lengthening of the period between flowering and maturity (Table 1.). It allowed the crop to harness more photosynthates during reproductive period of crop and thus contributed to the higher seed yield. Application of 45, 60 and 75 kg N ha^{-1} treatments required 121.13, 123.27 and 126.07 days to maturity, respectively.

Table 1: Effect of weed management and nitrogen levels on biochemical and phenological parameters of Indian mustard

Treatment	Chlorophyll content (mg g^{-1} fresh weight of leaves)		Phenological characteristics	
	60 DAS	90 DAS	Days to 50 % flowering	Days to maturity
Weed Management				
Pendimethalin 0.75 kg ha^{-1}	2.65	2.17	53.56	122.78
Oxadiargyl 0.09 kg ha^{-1}	2.67	2.25	53.00	123.44
Quizalofop-ethyl 0.05 kg ha^{-1}	2.66	2.18	54.01	123.89
One Hand weeding 25 DAS	2.75	2.28	52.45	123.33
Weedy Check	2.48	2.04	55.44	124.00
SEm±	0.04	0.03	0.86	0.70
CD (P=0.05)	0.10	0.08	NS	NS
Nitrogen levels (kg ha^{-1})				
45	2.48	2.08	54.87	121.13
60	2.67	2.19	53.13	123.27
75	2.79	2.28	53.07	126.07
SEm±	0.03	0.02	0.67	0.54
CD (P=0.05)	0.08	0.06	NS	1.58

Effect on seed oil content, seed and oil yield

One hand weeding (2240 kg ha^{-1}) was found significantly superior in enhancing seed yield of Indian mustard over pendimethalin and quizalofop-ethyl and closely followed by oxadiargyl (2234 kg ha^{-1}) (Table 2.). The per cent increase in seed yield due to pendimethalin 0.75 kg ha^{-1}, oxadiargyl 0.09 kg ha^{-1}, quizalofop-ethyl 0.05 kg ha^{-1} and one hand weeding 25 DAS was 41.16, 70.27, 26.14 and 70.73 per cent over weedy check (1312 kg ha^{-1}), respectively. Similarly, the superior weed management treatment with respect to oil yield of Indian mustard was one hand weeding 25 DAS (908 kg ha^{-1}) closely followed by oxadiargyl 0.09 kg ha^{-1} (899 kg ha^{-1}), while the performance of pendimethalin 0.75 kg ha^{-1} and quizalofop-ethyl 0.05 kg ha^{-1} was statistically at par in this regard with the respective values of oil yield as 722 and 661 kg ha^{-1}. Seed yield of the crop increased with each level of nitrogen application from 45 kg ha^{-1} to 75 kg ha^{-1}. Enhancement in rate of N from 45 to 60 and from 60 to 75 kg N ha^{-1} tended to increase seed yield by 17.20 and 10.17 per cent, respectively. Nitrogen application significantly increased oil yield of crop over the respective lower level of nitrogen. The per cent increase in oil yield was recorded under 60 and 75 kg N ha^{-1} as 20.70 and 32.64, respectively compared to 45 kg N ha^{-1}. Oil yield is a function of oil content of seed and seed yield. So, significant increased in oil yield might be ascribed due to significant increase in seed yield under weed management treatments and higher levels of N compared to weedy check and lower N levels, respectively. These results are in agreement with the findings of Kumar *et al.* (2012) [4].

Table 2: Effect of weed management and nitrogen levels on seed oil content, seed and oil yield

Treatment	Seed oil content (%)	Seed yield (kg ha^{-1})	Oil yield (kg ha^{-1})
Weed Management			
Pendimethalin 0.75 kg ha^{-1}	38.91	1852	722
Oxadiargyl 0.09 kg ha^{-1}	40.17	2234	899
Quizalofop-ethyl 0.05 kg ha^{-1}	39.84	1655	661
One Hand weeding 25 DAS	40.53	2240	908
Weedy Check	38.77	1312	510
SEm±	0.59	73	32

CD (P=0.05)	NS	210	93
Nitrogen levels (kg ha^{-1})			
45	38.89	1610	628
60	40.08	1887	758
75	39.96	2079	834
SEm±	0.46	56	25
CD (P=0.05)	NS	163	72

Conclusion

The research findings reveal that pre emergence application of oxadiargyl 0.09 kg ha^{-1} recorded the higher chlorophyll content, seed and oil yield comparable to one hand weeding treatment and application of 75 kg N ha^{-1} increased days to maturity by 4.94 days over 45 kg N ha^{-1} and resulted the highest seed and oil yield.

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