International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
www.chemijournal.com
IJCS 2020; 8(5): 644-646

Received: 27-07-2020
Accepted: 30-08-2020

Ardeep
Department of Agronomy, College of Agriculture, GB Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, India

MS Negi
Department of Agronomy, College of Agriculture, GB Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, India

BS Mahapatra
Department of Agronomy, College of Agriculture, GB Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, India

ST Pandey
Department of Agronomy, College of Agriculture, GB Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, India

Jai Paul
Department of Soil Science, College of Agriculture, GB Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, India

Corresponding Author:
Ardeep
Department of Agronomy, College of Agriculture, GB Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, India

Effect of residual fertility on oil quality of Indian mustard (*Brassica juncea* L. Czern & Coss)

Ardeep, MS Negi, BS Mahapatra, ST Pandey and Jai Paul

DOI: https://doi.org/10.22271/chemi.2020.v8.i5i.10375

Abstract
An experiment was conducted at Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, U.S. Nagar (Uttarakhand) India, during 2018-19 to study the effect of residual fertility of *sweet basil crop* on oil quality of succeeding mustard crop. From the study it was found that the oil quality of mustard variety PR 20 in terms of protein, oil content and fatty acid composition did not influence much with the recommended dose of fertilizer and residual fertility treatments. However, in sweet basil- mustard cropping system, the application of 120 kg N, 60 kg P_2O_5, 40 kg K_2O and 40 kg S ha^{-1} in sweet basil crop and growing mustard on residual nutrients improved the oleic acid content in mustard oil, which is consider good for human health.

Keywords: Fatty acids, mustard, oil quality, residual nutrients, sweet basil

Introduction
Fertilizers play a key role in agricultural production, but cultivation of major crops that rely on the use of high rates of inorganic fertilizer, continuously for several years, often lead to unsustainability in production and also pose a threat to the environment (Smith *et al*., 2000 and Harrison and Webb 2001) [18, 9]. The major concern is the development of multinutrient deficiency and fertilizer-related environment pollution. Similarly, increased prices and limited availability of fertilizer entail judicious use of chemical fertilizers, so that soil and environment can be saved from the hazardous chemical fertilizers which adversely affect human, animal and soil micro flora. Leaching of chemical fertilizers through rain water also affects aquatic life and causes various water related diseases. In this context an experiment was conducted which was based on judicious use of chemical fertilizers.
Sweet basil (*Ocimum basilicum* L.) is one of the most important essential oil-bearing crops and good source of linalool and methyl chavicol, which is widely used in various pharmaceutical preparations. India is the largest producer of sweet basil in the world. In India, Sweet basil is mainly grown in Uttar Pradesh and *tarai* belt of Uttarakhand. The major cropping systems being followed in this area are rice- wheat and rice-mustard (Brassica juncea). Due to diversification in agriculture now a days farmers also adopting sweet basil as a *kharif* season crop. Sweet basil- mustard cropping system is more economical because the cost of cultivation of mustard is less than wheat (Patra *et al*., 2000). An attempt has been made to assess the oil quality parameter of mustard on left over nutrients of *Ocimum basilicum* crop. In present experiment mustard crop was grown on residual nutrients of previous sweet basil crop to study the oil quality of mustard crop on residual nutrients.

Material and Methods
Experimental site
The experiment was carried out during Kharif – *rabi* season of 2018 and 2019 at Medicinal Plants Research and Development Centre (MRDC) of G.B. Pant University of Agriculture and Technology, Pantnagar, District U.S. Nagar (Uttarakhand), India. The experimental site classified as humid sub-tropical climate zone with severe hot and dry summers and cold winters (locally known as the *tarai* region). It situated at 29 ° N and 79.3º E latitude and at an altitude of 243.84 metre above mean sea level. The average rainfall of the region is 140 cm per annum of which about 85-90% is received from June to September. The maximum and minimum temperature ranges from 30 ºC to 43 ºC and 4.5 ºC to 26.7 ºC in summer and winter

respectively. The soil of the experimental site was sandy clay loam in texture, having pH 7.1, medium in organic carbon (0.74%), medium in available nitrogen (280.25 kg ha^{-1}), high in available phosphorus (28.14 kg ha^{-1}) and potassium (307.43 kg ha^{-1}) and sulphur (28.24 kg ha^{-1}).

Experimental design and treatment details

The experiment was laid out in Randomized Block Design (RBD) having six treatments with three replications. Sweet basil (*Ocimum basilicum*) variety CIM- Saumya was taken as annual with only single harvest in *kharif* season. The nursery was sown using 300 g seed for a hectare of land and 30 days old seedlings were transplanted at a spacing of 50 X 40 cm. After harvest of sweet basil mustard crop variety PR-20 was grown on residual nutrients with one treatment as recommended dose of fertilizer (RDF) to compare the mustard yield and qualitative characters with residual treatments. The treatment details of the experiment used for sweet basil have been presented in Table 1.

Table 1: Treatments details of sweet basil which was used as residual fertility levels in mustard crop

S. No.	**Fertility treatments** (N-P-K-S) kg ha^{-1}
F1	RDF: 120:40:40:20
F2	100:60:40:20 (Residual fertility)
F3	100:60:40:40 (-do-)
F4	120:60:40:0 (-do-)
F5	120:60:40:20 (-do-)
F6	120:60:40:40 (-do-)

Fatty acids analysis of mustard oil

The different saturated and unsaturated fatty acids (%) present in the mustard oil were estimated by using FT-NIR (Fourier Transform near Infrared Reflectance) spectroscopy.

Results and discussion

Protein content (%) of the mustard oil did not influenced with the recommended dose of fertilizers and residual fertility levels of previous kharif season crop. however, the maximum protein content 22.78% was recorded with the recommended dose of fertilizer while minimum content 22.45 was recorded in the residual fertility level of 120 kg N + 60 kg P_2O_5 + 40 kg K_2O + 40 kg S ha^{-1} (Table-2). Oil content of the mustard crop also did not vary significantly with different residual fertility levels. However, the maximum oil content 41.71% was recorded with the residual fertility of treatment 120 kg N + 60 kg P_2O_5 + 40 kg K_2O + 40 kg S ha^{-1} and minimum with the application of recommended dose of fertilizers. The fatty acids can be divided into saturated and unsaturated fatty acids based on their nature. All the unsaturated fatty acids of oil did not differ significantly with the residual fertility levels of the soil except erucic acid and oleic acid which were significantly influenced by the residual fertility levels of the *kharif* season crop. Erucic acid content was significantly influenced by the different residual fertility levels of soil after harvest of sweet basil crop. The significantly higher erucic acid 23.82% was recorded with the application of recommended dose of fertilizers. The minimum erucic acid content (22.12%) was recorded with the residual fertility level of 100 kg N + 60 kg P_2O_5 + 40 kg K_2O + 20 kg S ha^{-1}. Linoleic acid content in the mustard oil did not differ significantly by different residual fertility levels. However, the maximum linoleic acid 18.07% was recorded with the residual fertility level of 120 kg N + 60 kg P_2O_5 + 40 kg K_2O + 20 kg S ha^{-1} and the minimum linoleic acid content was found with the application of recommended dose of fertilizers. Oleic acid content was significantly influenced by the different residual fertility levels (Table-2). The significantly higher oleic acid content 2.36% was found with the application of recommended dose of fertilizer. However, it was *on a par* with 120 kg N + 60 kg P_2O_5 + 40 kg K_2O + 40 kg S ha^{-1} and 120 kg N + 60 kg P_2O_5 + 40 kg K_2O + 20 kg S ha^{-1}. The minimum oleic acid content 2.03% was found in residual fertility of treatment of 100 kg N + 60 kg P_2O_5 + 40 kg K_2O + 20 kg S ha^{-1}. Linolenic acid content did not influence significantly by the different residual fertility levels. However, the maximum linolenic acid 11.08% was recorded with the residual fertility level of 120 kg N + 60 kg P_2O_5 + 40 kg K_2O + 20 kg S ha^{-1}. The minimum linolenic acid content was recorded with the application of recommended dose of fertilizers.

Saturated fatty acids of the mustard oil (Palmitic acid and steric acid) also did not influence by the recommended dose of fertilizers and residual fertility levels (Table-2). However, the maximum values of palmitic acid and steric acid content was recorded with residual fertility level of 120 kg N + 60 kg P_2O_5 + 40 kg K_2O + 40 kg S $ha^{-1}$and minimum values with the recommended dose of fertilizers.

Oil and protein content are most important quality traits of mustard crop. The increase in protein content was mainly due to the increase in nitrogen availability in the soil. It may be stated that higher availability of nitrogen in plant synthesized more carbohydrate which may be converted more rapidly into protein than fat which in turn enhanced the protein content in seed. Similar results were also recorded by Dubey and Khan (1993) [6] and Meena and Sumeriya (2003) [13]. Application of nitrogen in treatment consisted of recommended dose of fertilizers reduced the oil content as compared to the residual fertility levels. Kutcher *et al*. (2005) [12] stated that decrease in oil content with increase in nitrogen availability might be due to the dilution effect of increased seed yield with increased nitrogen fertilization and the inverse relationship of protein and oil content. Holmes (1980) [10] also reported that a better supply of nitrogen increases the formation of nitrogen containing protein precursors, so that protein formation competes more strongly for photosynthates, as a result less photosynthates are available for fat synthesis.

In respect of mustard oil quality assessment, free fatty acid is considered as an important quality parameter where, low quantity of free fatty acid in edible oils indicates generally good quality of oil for health point of view (Syam *et al*., 2009) [19]. Applications of nutrients also have positive effect on erucic acid content in mustard oil. Application of nitrogen promotes elongation of the carbon chain of linoleic acid and oleic acid to erucic acid and encourages the desaturation of oleic acid. Similar findings were also reported by Holmes and Bennett (1979) [11]. Application of nitrogen along with sulphur improves the linoleic acid (%) content in the mustard oil as sulfur is the constituent of the oil synthesis pathways thus influence the constituents of the oils by participating in various enzymatic reactions. Similar findings were also reported by Ahmad and Abdin, 2000 [2]. Application of sulphur along with nitrogen has significant effect on fatty acid composition in mustard seeds (Ahmad *et al.*, 1999) [3]. However, increase in oleic acid is coincided with decrease in linoleic acid and this might be attributed to the effect of sulphur on omega-6- desaturase enzyme activity that converts oleic acid to linoleic acid. This result is in conformity with the work done by Afridi *et al*. (2002) [1], as they also reported non- significant effect of different varieties on oleic acid content. Increase in nitrogen supply reduces oleic acid content

as nitrogen supply rates affect the rate of hydrolysis of fatty acids and their movement from proplastid to the cytosol. A similar trend of the increase in oleic acid content of sunflower was also reported by Flagella *et al*. (2002) [7]. Holmes and Bennett (1979) [11] reported that the linolenic acid content of mustard oil is mainly under genetic control and cannot be changed with the application of nutrients. Steric acid (%) and palmitic acid (%) compositions, being function of genotype and not much influenced with the availability of nutrients (Gao *et al.*, 2010) [8]. Similar finding were also reported by Bisht and Bisht (2007) [4, 5]. Now days we have varieties which have low palmitic acid content. Low palmitic acid improves the quality of mustard oil (Banga *et al.* 2007) [4].

Table 2: Oil quality of Indian mustard variety PR 20 as influenced by recommended dose of fertilizers (RDF) and residual fertility

S. No	Treatments	Protein %	Oil %	Unsaturated fatty acids				Saturated fatty acids	
				Erucic acid %	Linoleic acid %	Oleic acid %	Linolenic acid %	Palmitic acid%	Steric acid %
1.	120:40:20:20 (RDF)	22.87	40.67	23.82	16.03	2.36	10.47	4.32	0.92
2.	100:60:40:20	22.86	40.83	22.12	17.59	2.03	10.78	4.32	0.93
3.	100:60:40:40	22.74	41.58	22.27	17.82	2.13	11.06	4.43	0.90
4.	120:60:40:0	22.79	41.10	22.56	17.75	2.21	10.63	4.53	0.94
5.	120:60:40:20	22.53	41.60	23.05	18.01	2.27	10.83	4.60	0.94
6.	120:60:40:40	22.45	41.71	23.58	18.07	2.31	11.08	4.61	0.95
7.	CD (5%)	NS	NS	1.11	NS	0.11	NS	NS	NS

Conclusion

From the study it can be concluded that mustard oil content, protein content and fatty acid composition did not influence much with the residual fertility levels. However, in sweet basil- mustard cropping system, the application of 120 kg N, 60 kg P_2O_5, 40 kg K_2O and 40 kg S ha^{-1} in sweet basil crop can improve the oleic acid content of mustard oil when grown on residual nutrients, left over after harvest of sweet basil, as oleic acid is considered good for health.

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