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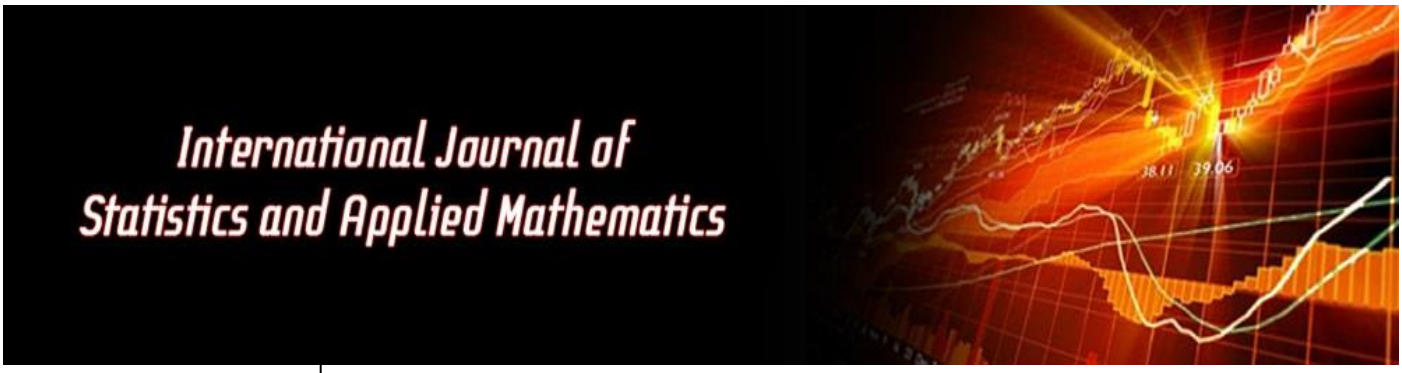

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Effect of different sulphur levels on various varieties of mustard (*Brassica juncea* L.) under late sown condition

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Abstract
A field experiment was conducted in four levels of sculpture (0, 20, 40 and 60 kg/ha) and three varieties of Indian mustard (NDR-8501, NDRE-4 and Vardan) at Agronomy Research Farm, Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad, during 2012-2013. Among various doses of sculpture, the application of 60 kg of S/ha was found optimum dose for increasing of seed yield (15.30 q/ha) and oil percentage (39.36%) content of mustard. Varieties tested during investigation (NDR-8501, NDRE-4 and Vardan), the NDR-8501was found suitable for getting higher seed yield (14.95 q/ha) and oil content (39.47%). The interacting effect of Sculpture on varieties remained non-significant during course of the study. Application of 40l g S/ha was found optimum for NDR-8501 Maximum net return (Rs 30489) was obtained when 40 Kg S/ha was applied and followed by 60 Kg/ha (Rs. 29497/ha). Benefit ratio (1:1.8) recorded with 40 Kg, 20 Kg S with NDR-8501.

Keywords: Sculpture, quality, *Brassica juncea* (L.), varieties, yield, economics

Introduction
Indian mustard (*Brassica juncea* (L.) Czerny & Cross) belongs to family Cruciferae. It is the most important winter (Rabi) oil seed crop. India is one of the largest mustard-growing countries in the world, occupying the first position in area and third position in production after China and Canada. Rape-seed and mustard is the third most important oilseed crop in the world after Soybean (*Glycine max*) and Palm (*Elaiesguineensis*). Among the seven edible oil seeds cultivated in India, rapeseed–mustard (*Brassica* spp.) contributes 28.6% in the total production of oil seed crops. Mustard is an important *rabi* crop of Rajasthan, Gujarat, M.P., Uttarakhand, Uttar Pradesh, Bihar, West Bengal and Assam. In India, cultivation of mustard is done over an area of about 5.92 million hectares with production and productivity of 6.78 million tons and 1145 kg/ha (2011-2012). In India, Rajasthan ranks first both in area and production, while and Gujarat has the highest productivity of mustard. In U.P., mustard is grown on 0.82 million hectares with a production of 0.90 million tons and productivity of 1141 kg/ha. Indian mustard markedly responded to sculpture fertilization in oilseeds, sculpture plays a vital role in the quality and development of seed. The importance of sculpture fertilization for increasing the yield and quality of Indian mustard is being increasingly recognized. However, the information regarding the optimum level of sculpture and its influences on seed yield and quality of different varieties of mustard is meagre. Probably for these reasons, the mustard crop needs a comparatively higher amount of sculpture for proper growth and development and higher yields. The Indian soils have generally been reported to be low in nitrogen, phosphorus and sculpture. Because of multiple cropping and the introduction of high-yielding varieties, the deficiency of these nutrients in the soil is becoming wider. The total sculpture content of Indian soil varies considerably ranging from 19 to 3836 ppm. So far its deficiency in soil has been reported from 65 countries and India is one of them. Out of the 400 districts in India, sculpture deficiency has been reported in 90 districts (Tandon, 1986) [12].

The sculpture is considered to occupy a fourth place among major plant nutrients after nitrogen, phosphorus and potassium (Nyborg and Bently, 1977; Borgan and Murphy, 1980; Mayer and Muraum, 1980) [7, 1, 6]. It in- creases phosphorus uptake by plants (Singh and Bairathi, 1980) [10] and nitrogen in protein synthesis and is indispensable for the synthesis of essential amino acids like cysteine, cysteine and methionine. Besides, the sculpture is also involved in various metabolic processes of plants. It is a constituent of glutathione, a compound supposed to be associated with the plant respiration and the synthesis of essential oils. The sculpture also plays a vital role in chlorophyll formation.

Materials and Methods

The experiment was conducted during the *Rabi* season of 2012-13, the at Agronomy Research Farm of Narendra Deva University of Agriculture & Technology, Narendra Nagar (Kumarganj), Faizabad (U.P.). The research farm is located in the main campus of the University. The field is located at the left side and near the Faizabad-Raibareily road at a distance of 42 Km away from Faizabad district headquarters. The experimental site falls under subtropical region in Indo-Gangetic plains with hot summer and cold winter indicating that weekly mean mini- mum and maximum temperature during the crop season ranged from 2.9 to 18.5 °C and 14.8 to 35.3 °C, respectively. A rainfall of 41.2 mm was re- corded in the month of Feb 2013. The evaporation rate varies from 0.7 mm to 5.7 in the month of December and March, respectively. The relative humidity was highest in the month of December (82.2) while the sunshine was recorded higher in the month of March. The physicochemical characteristics of soil and its fertility status, the soil samples were collected at random from 12 places of the field with the help of a soil auger to a depth of 0-20 cm in each and three replication before the application of fertilizers. The soil samples representing the whole field were taken and analysed in laboratory for physicochemical properties. The experiment was conducted in Randomized Block Design with three replications. There were twelve treatment combinations consisting of 4 levels of sculpture and 3 genotypes were allocated randomly. Sulphur were given through elemental sculpture. The experiment was laid out in a well-prepared field as per layout plan. The experiment consisting of twelve treatments were replicated three times randomly. The crop was fertilized with a uniform dose of nitrogen, phosphorus and potassium @ 120 Kg, 60 Kg and 40 kg/ha, respectively. The crop was sown on dated Nov.20th, 2012 using 6 Kg seed/ha in a row 30cm at a depth of 2-3 cm in furrows.

Results and Discussion

Yield

The presented data clearly showed that seed yield increased significantly with increase in levels of sculpture. The maximum seed yield of 15.30 q/ha was obtained at the highest dose of sculpture (60 Kg S/ha) and found significantly superior over other treatments including the control (11.25 q/ha) given in (Table-1). The highest seed yield (14.95 q/ha) was obtained in NDR-8501 and the minimum seed yield (12.40) observed from NDRE-4. The interaction effect between sculpture and varieties was observed to be non-significant. Stover yield increased with increasing levels of sculpture. The highest Stover yield (44.83 q/ha) was obtained with application of 60 kg S/ha which was better than other treatments including control (35.56 q/ha). NDR-8501 produced significantly higher stover yield of (42.94 q/ha) than that of NDRE-4 and Vardan. The Interaction effect between sculpture and variety was non-significant. Harvest index was not-influenced significantly either by sculpture levels nor by varieties and their interaction The variation in biological yield, seed yield and stover yield are the results of variation in various growth and yield contributing characters and hence productivity of mustard is collectively determined by vagueness in the vegetative growth and increase in value of various yield attributes. The higher number of siliqua/plant, length of siliqua, number of seed/ siliqua and 1000-seed weight resulted into higher seed yield of mustard. Seed yield (15.30q/ha) and stover yield (44.83 q/ha) of mustard were significantly increased with a dose of sculpture up to 60 kg S/ ha than other treatments. The increase in seed yield under adequate sculpture supply might be ascribed mainly due to the combined effect of higher number of siliquae/plant, more number of seeds/siliqua and higher 1000 seed weight, which was result of better translocation of photosynthates from source to sink.

Table 1: Effect of sculpture levels and varieties on seed yield, stover yield harvest index and quality of mustard crop.

Treatments	Seed yield (q/ha)	Stover yield (q/ha)	Harvest index (%)	Oil content (%)
Sulphur levels (kg/ha) 0	11.25	35.56	24.02	38.36
20	13.09	39.97	24.62	38.85
40	14.56	42.65	25.41	38.99
60	15.30	44.83	25.41	39.36
S.E.M±	0.30	0.70	0.35	0.23\
CD (P=0.05)	0.88	2.07	1.04	0.69
Varieties NDR-8501	14.95	42.94	25.79	39.47
NDRE-4	12.40	38.64	24.20	38.90
VARDAN	13.30	40.68	24.60	38.28
S.E.M±	0.26	0.61	0.31	0.20
CD (*p*= 0.05)	0.77	1.79	0.90	0.60
S x V	NS	NS	NS	NS

Table 2: Economic of various treatment combinations in mustard.

Treatments Combination	Seed yield (q/ha)	Stover yield (q/ha)	Cost of Cultivation (Rs/ha)	Gross Return (Rs/ha)	Net return (Rs./ha)	B: CRatio
NDR-8501S0	12.44	37.67	22611	44854	22243	0.98
NDRE-4 S_0	10.19	33.49	22611	37268	14657	0.64
Vardan S0	11.13	35.52	22611	40494	17883	0.79
NDR-8501S20	14.76	42.68	24211	52816	28605	1.18

NDRE-4 S20	12.08	37.65	24211	43770	19559	0.80
Vardan S20	12.42	39.57	24211	45174	20963	0.86
NDR-8501S40	15.84	43.90	25811	56300	30489	1.18
NDRE-4 S_{40}	13.56	41.28	25811	48936	23125	0.89
Vardan S40	14.28	42.77	25811	51394	25583	0.99
NDR-8501S60	15.90	45.95	27411	56890	29479	1.07
NDRE-4 S60	13.76	42.12	27411	49704	22293	0.81
Vardan S60	15.37	44.87	27411	55084	27673	1.00

Sulphur also stimulates the seed setting, seed formation and oil synthesis in the seeds of mustard and it increases the biological, seed, Stover yield and harvest index of mustard. Chandel *et al.* (2002) [2]; Rana *et al.* (2005) [8] and Dongarkar *et al.* (2005) [3] also re- ported the similar results.

Quality Parameter

Data presented Oil content increased with in- creasing levels of sculpture. The maximum oil content (39.36%) was recorded with application of 60 kg S/ ha which was significantly higher than other treatments including control (38.36%). The maximum oil content (39.47%) was found in NDR-8501 which was higher over Vardan (38.28%) and NDRE-4 (38.90%) given in (Table-1). Non-significant interaction between sculpture levels and varieties in was obtained was found. The higher oil content in seed was recorded with the application of 60 kg S/ha, which was significantly superior over control. This was probably due to the fact that the sculpture is a constituent of lipids and it is also essential for the synthesis of lipids. Therefore, higher levels of sculpture increased the oil content in mustard. Similar results were also obtained by Issa and Sharma (2006) [4], Kumar and Yadav (2006) [5] and Singh *et al.* (2010) [11].

Economics

The main objective of any experiment is to find out the maximum profit with minimum cost of cultivation. With this aim, the treatments which have given high profit are worth adopting. Under the eco- nomic analysis of results, the common cost of cultivation was calculated on the basis of prevailing rates of different commodities. Based on the input-output analysis, the net income, cost of production and net profit per rupee invested were worked out to know the commercial feasibility for the adoption of recommendations. Economics of different treatments has been presented this obviously indicates that sculpture increased the cost of cultivation markedly. The maximum cost of cultivation recorded at the application of 60 kg S/ha. On the basis of net profit, the highest net profit (Rs. 30489) was found at combination of 40 kg S/ha with NDR-8501 variety followed by Rs. 29479 at a combination of 40 kg S/ha with NDR- 8501 variety given in (Table-1). Whereas the mini- mum net profit (Rs. 14657) was obtained at a combination of no application of sculpture with NDRE-4. On the benefit: Cost ratio the highest net profit per rupee invested was (1.18 rupee) obtained at 40 kg S/ ha in the NDR-8501 variety. Whereas, the lowest net profit per rupee investment was (0.64 rupee) found at a combination of variety NDRE-4 along with 0 kg S/ha. The variation in the cost of cultivation was re- corded due to variation in sculpture doses. Similar results have been also found by Sardana *et al.* (2008) [9].

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