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Effect of nutrient management on productivity of Indian mustard

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Abstract
A field experiment was conducted during *rabi* season of 2017-18 at Agriculture Farm, Bhagwant University, Ajmer to study the effect of nutrient management on growth yield and quality of mustard. The study used a randomised block design with three replications, with a total of ten treatments. Results indicated that application of nutrient management treatments increased growth and yield parameters. When compared to control and water spray, 100% RDF + 2% urea + 2% multiplex spray resulted in significantly higher plant height at 30, 60, 90 DAS and at harvest, number of functional leaves/plant at 30, 60 and 90 DAS, LAI at 30 and 60 DAS, dry matter accumulation at 30, 60, 90 DAS and at harvest, number of branches/plant, number of siliqua/plant, number of seeds/siliqua, test weight, seed yield and stover yield.

Keywords: mustard, nutrient, urea, multiplex and yield

Introduction
Indian mustard (*Brassica juncea* (L.) Czern. & Coss) is the second most important oilseed crop after soybean in the country and has also been cultivated on significant area in north India since last one decade. Rapeseed-mustard production accounts for 26.0 percent of India's total oilseed production. Only half of the overall demand for edible oils is met by domestic production, with the remainder coming from abroad. The enormous gap between domestic use and production of edible oils can be bridged by either expanding the area under oilseed crops like rapeseed and mustard, sunflower and soybean, or boosting production per unit area. Oleic, linoleic, linolenic, ecosenoic, and erucic acid are the primary fatty acids found in rapeseed and mustard oil, respectively (Chauhan *et al.* 2007) [2]. Each gram of fats and oils provides 9 kcal of energy, whereas each gram of carbohydrate/protein provides approximately 4 kcal of energy (Alam *et al.* 2014) [1]. Essential fatty acids can also be found in fats and oils. Phospholipids, which are crucial components of active tissues such as the brain, nerves, and liver of humans and other animals, are synthesised from fats and oils.
The only way to increase productivity in a resource-constrained environment is to produce more oilseeds. The unbalanced and insufficient supply of fertilizers, combined with the limited application of organic manures, not only limits yield potential, but also depletes soil nutrients, causing soil health to degrade and crop responsiveness to drop. Due to variable soil moisture and nutritional quality, various trends in seed yield of Indian mustard have been seen under different agro-climatic conditions. It responds to a variety of plant nutrients, including nitrogen, phosphorus, and sulphur. In mustard, nutrients have a critical function in enhancing seed yield. It was discovered that foliar treatment of important nutrients like nitrogen and potassium was as effective as soil application. The leaves of most crop plants can absorb urea quickly and effectively. Application of sulphur was reported to increase yield attributes and yield of Indian mustard and also increased S uptake as well as oil content. The objectives of this study were to examine the effect of nutrient management on productivity of Indian mustard.

Material and Methods
The field experiments were conducted at Agriculture Farm, Bhagwant University, Ajmer, Rajasthan, India (24º 40'N latitude and 82º 12'E longitude at an altitude of 113 meters above mean sea level) during *rabi* season of 2017-18. At the start of the experiment, the soil in the experimental field was sandy clay loam, slightly alkaline in reaction (pH 7.1), with 190.50 kg/ha available nitrogen (Alkaline permanganate method, Subbiah and Asija, 1956) [15], medium available phosphorus of 19.30 kg/ha, (Olsen's method, Olsen *et al.*, 1954)[11], and medium

available potassium of 210.13 kg/ha, (Flame photometric method (Metson, 1956) [9] in 0-15 cm soil depth. The experiment comprising total 10 treatment combinations such as control, water spray, 2% urea spray, 100% RDF, 50% RDF + 2% urea spray, 50% RDF + 2% multiplex spray, 50% RDF + 2% urea + 2% multiplex spray, 100% RDF +2% urea spray, 100% RDF + 2% multiplex spray and 100% RDF + 2%urea + 2% multiplex spray in randomized block design with three replications. Recommended dose of fertilizer is 40 kg N, 20 kg P_2O_5, 20 kg K_2O and 20 kg S per hectare. Indian mustard variety 'Varuna' was sown on 10.11.2017 with using seed rate of 5.0 kg ha^{-1} at the row spacing of 45 cm. All the recommended package of practices was followed to raise the crop. Growth and yield parameters were recorded as per standard practice. The plant height at 30, 60, 90 DAS and at harvest, number of functional leaves/plant at 30, 60 and 90 DAS and dry matter accumulation at 30, 60, 90 DAS and at harvest was measured from randomly selected five plants from each plot. Number of branches counted from five plants per plot. Yield attributing parameters viz, number of siliqua/plant, number of seeds/siliqua, test weight were measured. Seed and stover yield also measured at after harvest of crop. Experimental data recorded in various observations were statistically analyzed with the help of Fisher's analysis of variance technique (Fisher, 1950) [5]. The analysis of data of the various treatments was compared together using CD at 5% significant levels.

Results and Discussion

Effect of nutrient management treatments on growth parameters

At all growth stages, nutrients had an effect on plant height, number of functional leaves/plant, leaf area index, dry matter accumulation, and number of branches/plant (Table 1). Basal application of 100% RDF produced the tallest plants at 30 DAS. However, at 60 DAS, 100% RDF + 2% multiplex had the maximum plant height, followed by 50 percent RDF + 2% urea + 2% multiplex. However, the plant height with application of 100% RDF + 2% urea spray + 2% multiplex spray was the greatest at harvest; followed by 100% RDF + 2% multiplex spray. A careful examination of the data revealed that plant height increased at its fastest between 30 and 60 DAS (3.21 cm/day), but then slowed between 90 DAS and harvest (0.29 cm/day). From 30 DAS to 60 DAS, the rate of increase was highest with the application of 100% RDF + 2% urea spray (3.51 cm/day) and lowest with the control plot (2.84 cm/day). However, the rate of increase was highest with 50% RDF + 2% urea spray (0.63 cm/day) between 90 DAS and at harvest, followed by spraying 2% urea spray (0.47 cm/day). Treatments at 30, 60, and 90 DAS resulted in significant increases in the number of functioning leaves per plant. At all three stages, soil application of 100 percent RDF with foliar application of 2% urea and 2%t multiplex produced significantly more functional leaves/plant than the other treatments, followed by 100% RDF and 2% multiplex spray and 100% RDF and 2% urea spray. During the three stages of observation, however, neither the control plot nor the water sprayed plots had the lowest number of functioning leaves. LAI grew with crop age until it reached 60 DAS. When compared to their values at 60 DAS, the leaf area index was reduced at 90 DAS. At all stages of the study, nutrient delivery to the soil and foliar application of nutrients greatly raised the LAI. Maximum values of LAI were observed to be 2.83 and 2.63, respectively at 60 and 90 DAS with application of 100% RDF+2% urea + 2% Multiplex followed by 100% RDF + 2% multiplex spray and 100% RDF +2% urea spray and were statistically similar among each other at both the stages.

Significantly highest dry matter accumulation was obtained with the application of 100% RDF+2% urea + 2% multiplex spray followed by 100% RDF +2% multiplex spray and 100% RDF+2% urea spray. At 30, 60 and 90 DAS, application of 100% RDF + 2% urea + 2% multiplex spray recorded higher dry matter accumulation, but it was at par with 100% RDF + 2% multiplex spray and significantly superior to rest of the treatments. While at harvest, 100% RDF + 2% urea + 2% multiplex spray resulted significantly higher dry matter accumulation as compared to control, water spray, 2% urea spray, 100% RDF, 50% RDF + 2% urea spray, 50% RDF + 2% multiplex spray, 50% RDF + 2% urea spray + 2% multiplex spray, 100% RDF + 2% urea spray and 100% RDF + 2% multiplex spray. Data presented in table 2 showed that the highest number of primary and secondary branches was recorded with the application of 100% RDF + 2% urea + 2% multiplex spray followed by 100% RDF + 2% multiplex, 100% RDF +2% urea spray and 50% RDF + 2% urea + multiplex which were found comparable among themselves and significantly superior to rest of the treatments.

At all phases of plant growth, foliar applications of 100% RDF+2% urea + 2% Multiplex spray, resulted in significant increases in plant height, number of leaves, number of branches, and dry matter production. The basal dose of fertilizer (40-20-20-20 kg N-P_2O_5-K_2O-S per hectare) combined with a foliar spray of nutrients in the form of urea and Multiplex gave ample amounts of nitrogen, phosphorous, potassium, sulphur, and micronutrients for the crop's growth and development. The greater uptake of nitrogen, phosphorus, potassium, sulphur, and micronutrients explains the treatment's superiority. Nitrogen is found in proteins, amino acids, nucleic acids, nucleotides, enzymes, alkaloids, vitamins, chlorophyll, and other living organisms. Photosynthesis, respiration, and protein synthesis are all aided by it. Similarly, phosphorus is a structural component of the cell's membrane system, chloroplasts, and mitochondria. It's found in ATP, ADP, nucleic acids, phospholipids, and the co-enzyme NAD, as well as NADP. It aids plant development by stimulating early root formation and expansion. It promotes the growth of reproductive organs, resulting in maturity. Potassium, on the other hand, acts as a catalyst in a variety of physiological processes, including glucose metabolism, nitrogen metabolism, and protein synthesis. It gives plants hardiness and disease resistance. Sulphur is extremely important to the mustard crop, as it aids in raising oil content and production. As a result, plants that received adequate levels of all major and micronutrients accumulated more photosynthates, resulting in higher dry weight. Pradhan *et al.* (1994) [12], Singh and Meena (2004) [13], Kumar *et al.* (2010) [8], and Mohiuddin *et al.* (2011) [10] all reported similar findings.

Table 1: Effect of nutrient management on growth parameters of mustard

Treatments	Plant height (cm)				Functional leaves/plant			Leaf area index	
	30 DAS	60 DAS	90 DAS	At harvest	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS
Control	13.4	98.7	113.8	123.0	3.25	30.50	40.20	2.21	1.70
Water Spray	15.1	106.4	115	123.2	3.25	30.45	40.25	2.24	1.72
2% urea spray	16.6	105.8	118.1	132.1	4.10	32.20	41.00	2.53	2.24
100% RDF *	16.8	111.3	123.3	132.2	4.50	33.00	41.60	2.60	2.26
50% RDF + 2% urea spray	15.5	101.2	114.7	133.7	5.20	35.00	42.00	2.55	2.32
50% RDF + 2% multiplex spray	17.9	118.5	130.3	135.4	5.20	35.00	44.20	2.58	2.45
50% RDF + 2%urea + 2% multiplex spray	17.1	118.5	130.3	135.4	5.75	36.50	46.00	2.61	2.50
100% RDF +2% urea spray	16.5	122.0	135.7	135.8	6.20	38.00	46.50	2.70	2.55
100%RDF + 2% multiplex spray	17.1	122.3	140	143.3	6.30	38.00	47.01	2.80	2.61
100% RDF + 2% urea + 2% multiplex spray	17.7	120.0	133.6	145.5	6.50	40.00	48.51	2.83	2.63
SEm	0.64	2.35	3.59	3.85	0.08	1.28	1.30	0.03	0.07
L.S.D (p=0.05)	1.34	4.94	7.55	8.08	0.21	3.45	3.61	0.10	0.20

Table 2: Effect of nutrient management on growth parameters of mustard

Treatments	Dry matter accumulation (g/plant)				Number of branches/plant		
	30 DAS	60 DAS	90 DAS	At harvest	60 DAS	90 DAS	At harvest
Control	1.70	15.00	30.50	36.00	2.1	4.3	4.8
Water Spray	1.80	15.85	31.00	36.20	2.7	4.5	5.9
2% urea spray	2.00	22.48	45.20	58.25	3.6	4.7	6.2
100% RDF *	2.40	24.50	50.00	62.00	4.5	6.2	6.8
50% RDF + 2% urea spray	2.00	24.00	48.50	59.50	4.7	6.3	7.6
50% RDF + 2% multiplex spray	2.40	22.40	45.50	56.25	4.4	7.0	7.1
50% RDF + 2%urea + 2% multiplex spray	2.30	26.00	51.00	62.50	4.3	7.4	9.3
100% RDF +2% urea spray	2.60	26.50	54.00	66.25	6.0	7.8	9.4
100%RDF + 2% multiplex spray	2.80	27.50	56.45	68.50	5.8	8.4	9.9
100% RDF + 2% urea + 2% multiplex spray	3.00	28.00	58.60	72.00	6.4	9.8	11.9
SEm	0.20	0.41	0.82	0.85	0.60	0.11	1.04
L.S.D (p=0.05)	0.42	1.22	2.41	2.46	1.26	0.24	2.18

Effect of nutrient management treatments on yield attributes and yield

Results (Table 3) revealed the application of nutrients management treatments considerably altered yield attributes and yield of mustard (Table 3). In comparison to the other treatments, the application of 100%RDF + 2% urea + 2% multiplex spray resulted in the highest number of siliqua/plant (5.40), length of siliqua (176.00 cm), and number of seeds/siliqua (11.70). The application of 100% RDF + 2% urea + 2% multiplex foliar spray resulted in the highest test weight, which was comparable to the application of 100% RDF + 2% multiplex spray and 100% RDF +2% urea spray. Under water spray and control, the minimum test weight was observed. The amount of basal soil applied and the amount of nutrients provided foliar spray had a big impact on seed yield. The highest seed yield of 956 kg/ha was achieved with the application of 100% RDF + 2% urea + 2% multiplex spray (924.3 kg/ha), which was statistically comparable to the application of 100% RDF + 2% multiplex spray (916.2 kg/ha) and significantly superior to the other treatments (Table 3). Table 3 shows that nutrient applications in the soil and on the leaves had a significant impact on stover yield. With the application of 100% RDF +2% multiplex spray, the maximum stover production of 3814 kg/ha was achieved, followed by 100% RDF + 2% urea + 2% multiplex spray, and control (1741 kg/ha) (Table 3). Singh *et al.* (2007) [14], Dawson *et al.* (2009) [4], and Mohiuddin *et al.* (2010) found a good link between the number of siliqua and seed weight per plant and mustard seed yield among the various yield parameters. The application of both foliar and basal doses of nutrients, rather than the complete required dose of fertilizer as basal, resulted in better seed yield and other yield characteristics. Khan (1996) [7] observed that basal applications of 60 kg N, 10 kg N, and 600 ppm Ethrel as foliar applications resulted in the maximum seed yield. Foliar spray was found to be superior to seed and stover yield in mustard by Khan and Qassem (2008) [6] and Dadheech *et al.* (2014) [3].

Table 3: Effect of nutrient management on yield attributes and yields of mustard

Treatments	Yield attributes				Yields (kg/ha)	
	Length of siliqua (cm)	Number of siliqua/plant	Number of seeds/siliqua	Test weight (g)	Seed	Stover
Control	4.12	80.30	9.44	4.29	453	1741
Water Spray	4.20	83.70	9.46	4.31	455	2053
2% urea spray	2.50	84.40	10.10	4.65	570	2149
100% RDF *	4.55	121.70	10.25	5.00	656	2229
50% RDF + 2% urea spray	4.46	134.50	10.00	5.00	731	2731
50%RDF + 2% Multiplex spray	4.40	148.20	9.50	4.75	790	2673
50% RDF + 2%urea + 2% Multiplex spray	4.53	143.20	10.20	5.10	823	3171
100% RDF +2% urea spray	5.00	143.70	10.10	5.21	916	3814
100%RDF + 2% Multiplex spray	5.20	148.00	11.15	5.35	924	3248
100% RDF + 2%urea + 2% Multiplex spray	5.40	176.00	11.70	5.40	23.02	1.55
SEm	0.05	11.76	0.08	0.04	48.36	3.27
L.S.D (p=0.05)	0.14	24.74	0.24	0.13	453	1741

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