Effect of Different Levels of Nitrogen, Phosphorous and Potassium on Growth, Yield Attributes and Yield of Indian Mustard (Brassica juncea (L.) Czern and Coss) in S-E Rajasthan

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A field experiment was conducted at Agricultural Research Station, Kota during the Rabi seasons 2019-20 to find out suitable nutrient management levels of nitrogen, phosphorous and potassium in irrigated condition of south-eastern Rajasthan. The treatments comprised three levels of nitrogen (80, 100 and 120 kg/ha), two levels of phosphorous (40 and 50 kg/ha) in main plot and three levels of potassium fertilizer (15, 30 and 45 kg/ha) in sub plot were laid out in split-plot design with 3 replication. Application of 120 kg N/ha had significance effect at harvest, over 80 kg N/ha, on plant height (224.5 cm), dry matter/meter row length(346.8 g), primary and secondary branches/plant (5.82 and 15.02), siliquae/plant (213.8), seeds/siliqua (15.94), length of siliqua (5.53 cm), 1000-seed weight (5.30 g), seed yield (2861 kg/ha) and stover yield (7016 kg/ha) however, 120 kg N/ha was remained on par with 100 kg N/ha. The application of 50 kg P2O5 had significant effect on dry matter accumulation per meter row length (329.64 g), height at 60 and 90 DAS (91.6 and 191.1 cm) primary and secondary branches/plant (5.45 and 14.66) siliquae/plant (204.3), seeds/siliqua (15.94), length of siliqua (5.43 cm), 1000-seed weight (5.19 g), seed yield (2830 kg/ha) and stover yield (6929 kg/ha). The application of 45 kg K2O/ha was had significant effect compared to 15 kg K2O/ha, on plant height (210.5 cm) dry matter accumulation per meter row length (334.2 g), primary branches/plant (5.46), siliquae/plant (203.2), seeds/siliqua (16.03), length of siliqua (5.46 cm), 1000-seed weight (5.17 g) seed yield (2856 kg/ha) and stover yield (7050 kg/ha). However 45 kg K2O/ha was found on par with 30 kg K2O/ha. The application of 100 kg N with 50 kg P2O5 and 30 kg K2O/ha was found beneficial for obtaining high seed yield in irrigated conditions of south-eastern Rajasthan.

Keywords
Indian mustard, Nutrient management, Seed yield, Stover yield

Abstract
A field experiment was conducted at Agricultural Research Station, Kota during the Rabi seasons 2019-20 to find out suitable nutrient management levels of nitrogen, phosphorous and potassium in irrigated condition of south-eastern Rajasthan. The treatments comprised three levels of nitrogen (80, 100 and 120 kg/ha), two levels of phosphorous (40 and 50 kg/ha) in main plot and three levels of potassium fertilizer (15, 30 and 45 kg/ha) in sub plot were laid out in split-plot design with 3 replication. Application of 120 kg N/ha had significance effect at harvest, over 80 kg N/ha, on plant height (224.5 cm), dry matter/meter row length (346.8 g), primary and secondary branches/plant (5.82 and 15.02), siliquae/plant (213.8), seeds/siliqua (15.94), length of siliqua (5.53 cm), 1000-seed weight (5.30 g), seed yield (2861 kg/ha) and stover yield (7016 kg/ha) however, 120 kg N/ha was remained on par with 100 kg N/ha. The application of 50 kg P2O5 had significant effect on dry matter accumulation per meter row length (329.64 g), height at 60 and 90 DAS (91.6 and 191.1 cm) primary and secondary branches/plant (5.45 and 14.66) siliquae/plant (204.3), seeds/siliqua (15.94), length of siliqua (5.43 cm), 1000-seed weight (5.19 g), seed yield (2830 kg/ha) and stover yield (6929 kg/ha). The application of 45 kg K2O/ha was had significant effect as compared to 15 kg K2O/ha, on plant height (210.5 cm) dry matter accumulation per meter row length (334.2 g), primary branches/plant (5.46), siliquae/plant (203.2), seeds/siliqua (16.03), length of siliqua (5.46 cm), 1000-seed weight (5.17 g) seed yield (2856 kg/ha) and stover yield (7050 kg/ha). However 45 kg K2O/ha was found on par with 30 kg K2O/ha. The application of 100 kg N with 50 kg P2O5 and 30 kg K2O/ha was found beneficial for obtaining high seed yield in irrigated conditions of south-eastern Rajasthan.

Introduction
Importance of oilseed in agriculture needs further attention, as they are valuable items of human nutrition and soil fertility. In India, rapeseed-mustard is grown over 5.96 million ha area with a production of 8.32 million tonnes at an average productivity of 1397
kg/ha (GOI, 2017-18). It is the most important rabi season oilseeds crop of Rajasthan which is grown on 2.38mha with annual production of 3.95mt at an average productivity of 1656 kg/ha (Anonymous, 2019-20). The optimum sowing time of Indian mustard in south-eastern Rajasthan is being grown on vertisols under irrigated conditions after harvest of urdbean /soybean without considering nutrient management which is essential for harvesting good yield.

Imbalanced use of chemical fertilizers especially N,P,K not only lowers productivity but also adversely affects soil health by continuous. Decline in crop yield due to lack of K supply was reported even in K rich soils like Vertisols (Singh and Wanjari, 2012). Furthermore, the inadequate supply of K also limits the responses to applied N and P fertilizer. Nitrogen deficiency may decrease yield while, excess N availability reduces the oil quality. Under the present situation application of major nutrient elements NP&K is essential for increasing mustard yield and maintaining crop production at higher level in irrigated condition.

Considering these facts, the present study was therefore, undertaken to evaluate the effect of different levels of nitrogen, phosphorous and potassium nutrient management for Indian mustard grown on Vertisol after harvest of urdbean in irrigated areas of south-west Rajasthan.

**Materials and Methods**

A field experiment was conducted at Agriculture Research Station, Kota (26º North latitude, 76º-6’ East longitude and 260 m above mean sea level) during the rabi seasons of 2019-20 to study the effect of different levels of nitrogen, phosphorous and potassium nutrient management on growth, yield attributes, seed yield, quality parameter and nutrient uptake were workout as per standard procedures. Growth, yield attributes, seed yield, quality parameter and nutrient uptake were studied. The gross plot size for each treatment was 6 m x 3.6 m and net plot size was 5 m x 2.7 m. The crop was harvested manually at physiological maturity stage as per treatments. Initial and post-harvest soil samples were collected from 0-15 cm depth, dried processed and analyzed for oxidizable organic carbon, N, P, K and S using standard procedures. Gross and net returns were calculated based on the seed and straw yield and prevailing market prices of mustard in respective seasons. The benefit cost ratio was calculated by dividing the net...
returns from the total cost of cultivation. The data were statistically analyzed and the results of pooled analysis are presented.

**Results and Discussion**

**Effect of Nitrogen**

Growth and yield attributes of Indian mustard were significantly influenced due to application of graded levels of Nitrogen fertilization contributed to a great extent in influencing the seed yield of mustard on account of its pronounced effect on the growth and yield attributes of the plant, at various stages of the crop growth. Application of 120 kg N/ha registered higher growth and yield attributing characters (Table 1) viz: plant height (224.5 cm), dry matter/meter row length (346.8 g), primary and secondary branches/plant (5.82 and 15.02), siliquae/plant (213.8), seeds/siliqua (15.94), length of siliqua (5.53 cm), 1000-seed weight (5.30 g). However there was no statistical difference between 100 and 120 kg N/ha. These growth and yield parameters increased significantly with increasing levels of nitrogen upto 100 kg N/ha. Probably 120 kg N/ha ensured the availability of other nutrient and favourable condition for growth of mustard plant. Nitrogen increase in size of cell, which expressed morphologically increased in plant height, leaf area and branches/plant.

Nitrogen provide deep green colour to leaves due to better chlorophyll synthesis which increase the effective area of photosynthesis and resulting in higher dry matter. These results are in conformity with finding of Singh and Kumar, (2014)

The application of 100 kg produced significantly higher (Table 2) seed yield and stover yield as compared to 80 kg N/ha however, it was found at pat with 120 kg N/ha. The maximum seed and stover yield were recorded with the application of 120 kg N/ha. The increase in yield of mustard due to nitrogen application may be because of the fact that nitrogen played an important role in synthesis of chlorophyll and amino acids, which constitute building of protein blocks.

Nitrogen influenced the seed yield through a source-sink relationship and in addition to higher production of photosynthates it leads to increased translocation to reproductive parts. Nitrogen being a most important plant nutrient needed for growth and development of plant and is known to increase the yield of Brassica species (Singh et al., 2002).

**Effects of phosphorous**

Application of 50 kg P₂O₅/ha recorded significantly the highest plant height at 60 and 90 DAS (Table 1) (91.6 and 191.1 cm) except at harvest, dry matter accumulation at all growth stages, primary and secondary branches/plant (5.45 and 14.66) siliquae/plant (204.3), seeds/siliqua (15.94), length of siliqua (5.43 cm), 1000-seed weight (5.19 g).

The seed yield (Table 2) (2830 kg/ha) and stover yield (6929 kg/ha) of mustard increased significantly due to application of 50 kg P₂O₅/ha over its lower level of phosphorus. The per cent increase in seed yield 8.22 was with 50 kg P₂O₅/ha level of phosphorus over 40 kg P₂O₅/ha level whereas the corresponding value for increase in stover yield was 4.50 per cent.

The supply of phosphorus to plant might have accelerated cell division and enlargement, carbohydrate, fat metabolism and respiration in plant. These results are in agreement with the findings of Rana et al., (2005) in mustard; Sune et al., (2006) in linseed; and Dhage et al., (2014) in soybean.
Table 1: Effect of nitrogen, phosphorous and potassium on plant height and dry matter accumulation at 60, 90 DAS and at harvest of Indian mustard

| Treatments    | At 60 DAS | At 90 DAS | At harvest |
|---------------|-----------|-----------|------------|
| Nitrogen (kg/ha) | Plant height (cm) | Dry matter/ m row length | Plant height (cm) | Dry matter/ m row length | Plant height (cm) | Dry matter/ m row length | Primary Branches/plant | Secondary Branches/plant |
| 80            | 79.0      | 136.5     | 169.7      | 226.0      | 193.1      | 295.4      | 4.38                    | 12.28                   |
| 100           | 87.5      | 153.6     | 188.4      | 252.1      | 202.4      | 332.5      | 5.24                    | 14.42                   |
| 120           | 99.8      | 155.7     | 196.8      | 259.6      | 224.5      | 346.8      | 5.82                    | 15.02                   |
| SEm ±         | 0.67      | 3.50      | 3.08       | 1.16       | 2.65       | 5.53       | 0.18                    | 0.43                    |
| CD (P=0.05)   | 2.62      | 13.74     | 12.09      | 4.54       | 10.41      | 21.72      | 0.72                    | 1.67                    |
| Phosphorous (kg/ha) |       |           |           |           |           |           |                         |                         |
| 40            | 85.9      | 144.6     | 178.82     | 241.1      | 206.0      | 320.09     | 4.84                    | 13.15                   |
| 50            | 91.6      | 152.5     | 191.19     | 250.4      | 207.3      | 329.64     | 5.45                    | 14.66                   |
| SEm ±         | 1.63      | 2.21      | 3.33       | 2.21       | 1.49       | 2.48       | 0.06                    | 0.22                    |
| CD (P=0.05)   | 5.62      | 7.63      | 11.51      | 7.66       | NS         | 8.59       | 0.22                    | 0.75                    |
| Potassium (kg/ha) |       |           |           |           |           |           |                         |                         |
| 15            | 84.7      | 145.00    | 181.7      | 239.0      | 201.7      | 317.3      | 4.83                    | 13.43                   |
| 30            | 88.9      | 150.22    | 183.7      | 246.5      | 208.0      | 323.1      | 5.15                    | 13.99                   |
| 45            | 92.7      | 150.59    | 189.7      | 252.1      | 210.2      | 334.2      | 5.46                    | 14.29                   |
| SEm ±         | 1.12      | 3.08      | 2.33       | 2.58       | 1.93       | 4.49       | 0.13                    | 0.25                    |
| CD (P=0.05)   | 3.28      | NS        | NS         | 7.54       | 5.63       | 13.09      | 0.39                    | NS                      |
Table.2 Effect of nitrogen, phosphorous and potassium on silique/plant, seeds/plant, siliqua length, 1000-seed weight, seed and stover yield, of India mustad

| Treatment      | Siliquae/plant | Seeds/siliqua | Siliqua length (cm) | 1000 seed weight (g) | Seed yield (kg/ha) | Stover Yield (Kg/ha) |
|----------------|----------------|---------------|---------------------|----------------------|--------------------|----------------------|
| Nitrogen (kg/ha) |                |               |                     |                      |                    |                      |
| 80             | 173.3          | 14.88         | 5.04                | 4.70                 | 2544               | 6433                 |
| 100            | 201.3          | 15.71         | 5.33                | 5.12                 | 2764               | 7009                 |
| 120            | 213.8          | 15.94         | 5.53                | 5.30                 | 2861               | 7016                 |
| SEM ±          | 7.31           | 0.19          | 0.07                | 0.10                 | 40.45              | 51.27                |
| CD (P=0.05)    | 28.69          | 0.73          | 0.29                | 0.40                 | 158.80             | 201.27               |
| CV (%)         | 15.81          | 5.11          | 5.93                | 8.64                 | 6.30               | 3.19                 |
| Phosphorus (kg/ha) |            |               |                     |                      |                    |                      |
| 40             | 187.9          | 15.08         | 5.18                | 4.93                 | 2615               | 6710                 |
| 50             | 204.3          | 15.94         | 5.43                | 5.19                 | 2830               | 6929                 |
| SEM ±          | 1.78           | 0.22          | 0.06                | 0.03                 | 51.97              | 18.81                |
| CD (P=0.05)    | 6.15           | 0.76          | 0.22                | 0.12                 | 179.81             | 65.09                |
| CV (%)         | 4.71           | 7.36          | 6.31                | 3.42                 | 9.92               | 1.43                 |
| Potassium (kg/ha) |            |               |                     |                      |                    |                      |
| 15             | 187.2          | 14.94         | 5.11                | 4.85                 | 2557               | 6634                 |
| 30             | 197.9          | 15.56         | 5.36                | 5.16                 | 2756               | 6774                 |
| 45             | 203.2          | 16.03         | 5.46                | 5.17                 | 2856               | 7050                 |
| SEM ±          | 4.31           | 0.25          | 0.05                | 0.07                 | 57.50              | 50.23                |
| CD (P=0.05)    | 12.58          | 0.74          | 0.14                | 0.21                 | 167.82             | 146.58               |
| CV (%)         | 9.33           | 6.89          | 3.79                | 6.04                 | 8.96               | 3.12                 |

**Effect of Potassium**

Among potassium levels, application of 30 kg K$_2$O/ha was found significantly superior with respect to plant height at 60 DAS (Table 1), dry matter accumulation per meter row length at harvest, primary branches/plant, number of siliquae/plant (197.3), seeds/siliqua (15.56), length of siliqua (5.46 cm), 1000-seed weight (5.17 g), seed yield (2756 kg/ha), biological yield (9877 kg/ha) and found at par with 45 kg K$_2$O/ha (Table 2). Whereas, secondary branches/plant and stover yield could not influenced significant by potassium levels. The maximum number siliquae/plant and number of seeds/siliqua in case of 60 kg K$_2$O/ha which could be attributed to favourable soil environments like better availability as well as absorption of water and nutrients due to balanced application of potassium that promoted vegetative and reproductive growth processes of the crop. The increase in oil content confirmed the findings of Misras (2003) in mustard.

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