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Mo Naushad

Ph.D. Scholar, Department of
Agronomy, Naini Agricultural
Institute, SHUATS, Prayagraj,
Uttar Pradesh, India

Punnam Chhetri

Senior Research Fellow, ICAR
KVK, East Sikkim Gangtok,
Sikkim, India

Shalini Bhawana Masih

Associate Professor, Department of
Mathematics & Statistics, Naini
Agricultural Institute, SHUATS,
Prayagraj, Uttar Pradesh, India

Rajesh Singh

Professor, Department of
Agronomy, Naini Agricultural
Institute, SHUATS, Prayagraj,
Uttar Pradesh, India

Yield performance of Wheat (*Triticum aestivum* L.) and Indian Mustard (*Brassica juncea* L.) intercropping system as influenced by row ratio and nitrogen management

Mo Naushad, Punnam Chhetri, Shalini Bhawana Masih and Rajesh Singh

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Abstract

A field experiment was carried during *Rabi* seasons of 2024-2025 at Crop Research Farm, Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P.), India. The present experiment consist of three intercropping systems viz., wheat + Indian mustard (4:1), wheat + Indian mustard (6:1), wheat + Indian mustard (8:1), row ratios in replacement series and five nitrogen management viz., RDF to both wheat + Indian mustard, 75% N to both wheat + Indian mustard + 1 Spray of Nano Urea Plus at 30 DAS, 75% N to both wheat + Indian mustard + 25% N through P.M., 75% N to both wheat + Indian mustard + 25% N through FYM and 50% N to both wheat + Indian mustard + 2 Spray of Nano Urea Plus at 30 and 45 DAS and two sole crops viz., wheat and Indian mustard. Results revealed that among the row arrangements maximum yield of wheat and Indian mustard were recorded under wheat + Indian mustard 8:1 row ratio. Whereas, among 50% N to both wheat + Indian mustard + 2 Spray of Nano Urea Plus at 30 and 45 DAS found to be superior over rest of the nitrogen levels tried. In case of yield parameter of wheat and Indian mustard treatment combination of wheat + Indian mustard (8:1) + 50% N to both wheat + Indian mustard + 2 spray of Nano Urea Plus at 30 and 45 DAS found best among all treatment combinations tried.

Keywords: Row ratio, nitrogen management, replacement series, wheat, Indian mustard and yield

Introduction

Agriculture land is shrinking day by day as it is used for non-agricultural purposes. It is rather inevitable to accommodate production in existing crops/cropping systems. The food requirement of the country by 2030 is expected to be around 300 million tones (Anon, 2005). This additional production has to come from existing land of cultivated area (143.8 million ha) and water resources. Increasing the resource use efficiency and vertical intensification of cropping system is the need of the hour. This can be achieved through intercropping (Sankaran and Rangasamy 1990) [9].

In India, wheat (*Triticum aestivum* L.) with Indian mustard (*Brassica juncea* L.) intercropping is an old and important cropping system under both irrigated and rainfed conditions. Growing cereals with pulses and oilseeds endowed with varying rooting depth and growth pattern help in better extraction of soil moisture and nutrients from different layers of the soil profile (Singh *et al.* 2018) [11].

Wheat is a major cereal crop, which plays an important role in food and nutritional security. It contains carbohydrate (70-72%) with considerable amount of protein (10-13%), fiber (11%), fat (3%). It occupies about 220 million hectares with a total production of 798.97 million tonnes and an average productivity of 3.62 t/ha globally (FAOSTAT, 2023) [3]. In India, wheat was grown on 32.80 million hectares, producing 117.94 million tonnes with an average productivity of 3,595 kg/ha during 2024-25. Uttar Pradesh remained the leading wheat-producing state, accounting for 9.60 million hectares of area and 35.65 million tonnes of production with a productivity of 3,714 kg/ha (Anonymous, 2025). Owing to its vital role in global food security, increasing wheat productivity has become essential. In India, where scope for horizontal expansion is limited, a production target of 140 million tonnes has been projected by 2050 to meet the growing food

Corresponding Author:

Mo Naushad

Ph.D. Scholar, Department of
Agronomy, Naini Agricultural
Institute, SHUATS, Prayagraj,
Uttar Pradesh, India

demand (Pal *et al.* 2023) ^[6]. Indian mustard (*Brassica juncea* L.) belongs to *Cruciferae* family and genus *Brassica*. Indian mustard is the third foremost edible oil seed crop after soybean and groundnut in India in terms of oil production. A number of elements, such as the 37–49% oil content, 38–57% eruric acid, 27% oleic acid, 17–25% proteins, 8–10% fibres, 6–10% moisture, and 10–12% extractable chemicals, all contribute to the high nutritional value of mustard seeds (Pandey *et al.*, 2013). India is fourth largest vegetable oil economy in the world next to USA, China and Brazil. Globally, rapeseed–mustard is cultivated over an area of about 40–42 million hectares, with a production of approximately 85–88 million tonnes and an average productivity of about 2.0–2.1 t/ha (FAOSTAT, 2023) ^[3]. In India, the crop covers about 8.66 million hectares with a production of 12.67 million tonnes and an average productivity of 1,463 kg/ha during 2024–25. Uttar Pradesh is among the major mustard-producing states, accounting for about 1.63 million hectares of area and 2.41 million tonnes of production, with a productivity of 1,474 kg/ha during the same period (Anonymous, 2025).

The selection of an appropriate intercropping system for each case is quite complex as the success of intercropping systems depend much on the interactions between the component species, available management practices and the environmental conditions. Intercropping provides year-round ground cover, or at least for a longer period than monocultures, in order to protect the soil from desiccation and erosion. By growing more than one crop at a time in the same field, farmers maximize water use efficiency, maintain soil fertility and minimize soil erosion, which are the serious drawbacks of mono-cropping (Tiwari *et al.* 2024) ^[13].

Nitrogen acts as the most responsive nutrient for wheat and mustard. Here FYM, poultry manure and nano urea are the way of giving the additional source of nitrogen that directly contribute to the wheat and mustard in intercropping system. Row ratios in intercropping play a major role in deciding the sunlight receptivity in wheat and mustard crop. In recent times, row intercropping has produced higher yields than mixed cropping. With variation in row ratio, growth and development of both crops are also being diverted, which eventually affects the yield attributes or yield (Shyamsunder *et al.* 2024) ^[10].

Keeping the above facts in mind, the present experiment was conducted at Crop Research Farm, Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P.) India

Materials and Methods

A field study was carried out during winter (*Rabi*) season of 2024–2025 at Crop Research Farm, Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj (U.P.), India. Present study carried out with 17 treatment combinations, which consisted of three intercropping systems viz., wheat + Indian mustard (4:1) (*I*₁), wheat + Indian mustard (6:1) (*I*₂), wheat + Indian mustard (8:1) (*I*₃), row ratios in replacement series and five nitrogen management viz., RDF to both wheat + Indian mustard (*N*₁), 75% N to both wheat + Indian mustard + 1 Spray of Nano Urea Plus at 30 DAS (*N*₂), 75% N to both wheat + Indian mustard + 25% N through P.M. (*N*₃), 75% N to both Wheat + Indian Mustard + 25% N through FYM (*N*₄) and 50% N to both wheat + Indian mustard + 2 Spray of Nano Urea Plus at 30 and 45 DAS (*N*₅) and two sole crops viz., wheat and Indian mustard. Sole cropping of wheat and

Indian mustard were kept for comparison. Thus, 17 treatment combinations were tested in split plot design, which were replicated thrice in which intercropping system were kept in main plot and nitrogen management in sub plots and experiment consisted of total 51 plots. The soil of experimental plot was sandy loam in texture having soil pH (7.7 and 7.2), low organic carbon (0.46 and 0.47%). The gross plot size was 4.5 m × 3 m (13.5 m²). Field preparation included one deep ploughing by 2 cross harrowing followed by planking. The seed rate of wheat is 120 kg/ha and for Indian mustard is 5 kg/ha were considered for sowing of crop during study. The crop was sown on 05/11/2024 with using K-1317 and Rohini variety for wheat and Indian mustard, respectively. A common spacing of 22.5 cm x 15 cm and 45 cm × 15 cm were adopted for wheat and Indian mustard for sowing. The recommended dose of fertilizer for wheat is 120 kg N, 60 kg P₂O₅ and 60 kg K₂O for Indian mustard 90 kg N, 45 kg P₂O₅ and 45 kg K₂O per hectare were applied through urea, DAP and MOP in sole crop only. In intercropping combinations, seed rate and fertilizers were calculated according to number of row arrangement. Foliar application of Nano Urea was applied at 30 and 45 DAS on both crops. Crop was raised under irrigated condition and a total of five irrigations were applied at 20, 40, 60, 80 and 100 DAS. Crop protection measures were followed as and when required. Wheat and Indian mustard were manually harvested 10 cm above ground, sun-dried in the field, then threshed, cleaned, dried, and weighed. The data were subjected to analysis of variance (ANOVA) in split-plot design for various observations (Gomez and Gomez, 1984) ^[4]. The results were presented at 5% level of significance (*P*=0.05) and critical difference (CD) values were calculated to compare the various treatments means.

Results and Discussion

Effect of row ratio and nitrogen management

The study revealed that significantly higher grain yield and straw yield of wheat and seed yield and stover yield of Indian mustard were recorded at 8:1 row proportion in wheat + mustard intercropping which was followed by 6:1 and 4:1. This could be ascribed to the inter-generic competition between the component crops for possible under and above ground resources, viz., space, nutrients and moisture. These results corroborated the findings of Singh *et al.* (2018) ^[11] and Srivastava *et al.* (2007) ^[12].

Among the nitrogen levels, grain yield and straw yield of wheat and seed yield and stover yield of Indian mustard were recorded maximum at 50% N to both wheat + Indian Mustard + 2 spray of Nano Urea Plus at 30 and 45 DAS. This may be due the application of nano fertilizer in conjugation with traditional nitrogen fertilizers improves nutrient absorption efficiency, enhanced photosynthesis, increases nutrient translocation and ultimately increases the economic and biological yield. When growth and yield parameters are increasing by Nano urea spray, overall yield will also increase. These results are close with results of Rani *et al.* (2024) ^[8].

The increase in yield might be directly associated with concomitant increase in growth and yield attributes of mustard plant, because of improved nutritional environment in the plant metabolic system leading to higher plant metabolism and photosynthetic activity due to Nano Urea. Similar finding was close vicinity of those reported by Bhadela *et al.* (2024) and Pandav *et al.* (2022) ^[7].

Table 1: Effect of row ratio and nitrogen management on yield of wheat and Indian mustard in wheat + Indian mustard intercropping system

Treatments	Wheat		Indian Mustard	
	Grain yield (t/ha)	Straw yield (t/ha)	Seed yield (t/ha)	Stover yield (t/ha)
Sole Wheat	4.730	7.512	-	-
Sole Indian Mustard	-	-	1.976	6.152
Row ratio (Intercropping system)				
Wheat + Indian Mustard (4:1)	3.282	4.601	0.655	2.567
Wheat + Indian Mustard (6:1)	3.684	6.271	0.825	2.862
Wheat + Indian Mustard (8:1)	4.350	7.292	1.047	3.384
F-test	S	S	S	S
SEm±	0.137	0.276	0.025	0.121
CD (P=0.05)	0.537	1.083	0.099	0.474
Nitrogen Management				
RDF to both Wheat + Indian Mustard	3.620	5.830	0.738	2.061
75% N to both Wheat + Indian Mustard + 1 Spray of Nano Urea Plus at 30 DAS	3.845	6.168	0.915	3.663
75% N to both Wheat + Indian Mustard + 25% N through P.M.	3.754	6.079	0.825	2.788
75% N to both Wheat + Indian Mustard + 25% N through FYM	3.663	5.948	0.794	2.430
50% N to both Wheat + Indian Mustard + 2 Spray of Nano Urea Plus at 30 and 45 DAS	3.978	6.248	0.941	3.746
F-test	S	S	S	S
SEm±	0.082	0.012	0.032	0.010
CD (P=0.05)	0.238	0.034	0.094	0.028

Conclusion

Based on the present investigation it is concluded that wheat intercropped with Indian mustard (8:1) row ratio along with 50% N to both wheat + Indian mustard + 2 spray of Nano Urea Plus at 30 and 45 DAS were found to be more productive.

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