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Effect of different row ratios and nutrient management strategies on growth, yield and quality of mustard in chickpea + mustard intercropping system

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Abstract

Chickpea + mustard is a prominent intercropping system of Indian sub continent under resource constraint conditions. The population ratio and nutrient management strategies have significant bearing on the performance and economic feasibility of component crops in mixed stands. An investigation was therefore undertaken on "Population Compatibility and Nutrient Management Strategies in Chickpea (*Cicer arietinum* L.) +Mustard (*Brassica juncea* L.) Intercropping Systems" at "Sardar Vallabhbhai Patel University of Agriculture and Technology", Meerut (U.P.) during *rabi* season 2017-18, to optimize planting geometry and devise effective nutrient management options. The experiment plot soil was sandy loam in texture with low organic carbon & available nitrogen, medium in available phosphorus & potassium with slightly alkaline pH. Twenty treatments consisting of combinations of 04 intercropping systems *viz.*, Chickpea + mustard in 3:1 and 4:1 row ratio and both in additive and replacement series and 05 nutrient management options *viz.*, recommended dose (RD) to chickpea and mustard both (N_1), N_1 + biofertilizers (N_2), N_2 +FYM (N_3), N_1 but mustard with 150% RD (N_4) and N_4 with biofertilizers (N_5) along with sole stand of component crops tested in RBD with 3 replications. Recommended doses were 100 kg DAP +20kg S ha^{-1} for chickpea and 120 kg N +40 kg P_2O_5+20 kg S for mustard. Nutrient application to mustard was made as per plant population against sole cropping. Chickpea seeds were inoculated with *Rhizobium* and mustard with *Azotobacter* while PSB was soil applied. The results revealed that except plant height all other growth parameters of mustard *viz*., number of branches, dry matter accumulation, yield attributes like number of seeds $siliqua^{-1}$, number of siliqua $plant^{-1}$ and yield were maximum in intercropping. A reverse trend was however noted in chickpea except for plant height. Nutrient management options had significant effect on performance of component crops being best in chickpea with recommended dose of nitrogen to component crops along with biofertilizers & FYM and mustard gave its best when its recommended dose was enhanced to 150% along with biofertilizers. Thus, chickpea yields got reduced under intercropping but mustard as intercrop not only compensated the chickpea yield losses but also gave additional yields and returns. Mustard raised in 4:1 additive series with chickpea proved to be remunerative with application of 100 kg DAP +20kg S ha^{-1} to chickpea + *Rhizobium* inoculation and 30 kg N, 10 kg P_2O_5& 5kg S ha^{-1} to mustard +*Azotobacter* inoculation along with soil application of PSB.

Keywords: Chickpea + mustard intercropping, additive series, replacement series, nutrient management, rhizobium, Azotobacter, growth, quality, yield

1. Introduction

Despite green, yellow, white and other like revolutions, still there is a huge gap in per capita calories, sugar, fat and protein consumption in India and developed countries. Protein and energy malnutrition of rural poor is a very common health concern. Launch of various schemes for boosting pulse and oilseed production like BGREI (Bringing Green Revolution in Eastern India), NFSM (National Food Security Mission- Pulses) etc., in the country reflects the Union government's concern on the matter. Though, India ranks first in the world in both area and production of pulses and oilseeds, major protein and energy sources, yet there is an alarming gap between demand and supply of these commodities. In 2017-18, total area under pulses in India was 28 million hectares with a production of about 20.5 million tonnes against the demand of 24 million tonnes (Directorate of Economics & Statistics, 2018). On oilseed front, India has made significant stride with an area and production of major oilseeds (9) being respectively 26.11 million hectare and 24.88 million tonnes whereas the total edible oil production in the country stood at 6.17 million tonnes in 2017-18. However, a gap in annual

growth of production (2%) and demand (6%) for vegetable oils and fats has been a concern. Rapeseed-mustard together with groundnut and soybean share 80 percent of area and 87 per cent in production of oilseeds. In the current scenario, oilseeds and pulses can hardly compete with rice and wheat in terms of quantum and certainty of production, returns and associated risks leaving a limited scope for their horizontal expansion. The only viable option is intensification of crops in time and space. Intercropping /multiple cropping are age old viable tools (Wahla *et al*., 2009 & Zhang and Li, 2003) [3] to improve land use efficiency (Seran *et al*., 2010; Khan *et al*., 2014). Besides intensification, intercropping addresses some of the major issues associated with modern agriculture i.e. moderate yields, pest and pathogen infestation, soil and environmental deterioration (Vandermeer, 1989) and efficient use of resources *viz.*, water, nutrients and solar energy (Nasri *et al*., 2014), thereby helping to deliver sustainable and productive agriculture (Lithourgidis *et al*., 2011). The most important advantage of intercropping system includes both tall and short plant components for their potential complementarily in sunlight utilization for crop production. Because of these advantages intercropping is practiced in many parts of the world. Furthermore, because of some favorable exudates from the component legumes, greater land-use efficiency, greater yield stability and increased competitive ability towards weed, intercropping is advantageous over mono-cropping.
Ahlawat *et al*., (2005) [2] observed that number of siliqua plant^{-1} and harvest index of mustard improved in intercropping with chickpea as compared with sole crop of mustard. Similarly, Tripathi *et al*., (2005) [20] reported from Kanpur, that all the yield attributing characters of mustard were higher in intercropped stand with chickpea over its sole cropping. Among the intercropping patterns, chickpea + mustard in 8:2 row ratio had higher values of yield attributes in mustard owing to lesser competition for nutrients, light, space and moisture and took more advantage of solar radiation. Chickpea and mustard are major *rabi* pulse and oilseed crops having seasonal, rhizospheric and micro-climate compatibility and therefore chickpea+mustard is a prominent intercropping system in Indian sub-continent particularly under resource constraint conditions. Chickpea +Mustard cropping system ensures more efficient use of land & labour, better control of weeds, insects/pests, and pathogens than sole cropping for the poor farmers (Singh and Rathi, 2003) [15]. Therefore, the present study was carried out to investigate effect of cropping system and nutrient management options on growth characteristics, yield attributes & yield and quality of mustard under chickpea + mustard intercropping system.

2. Materials and Methods

2.1 Experimental details

A field experiment was conducted during *rabi* season 2017-18 at Sardar Vallabh bhai Patel University of Agriculture and Technology, Meerut (U.P.), located at a latitude of 29^0 40’ North and longitude of 77^0 42’ East with an elevation of 237 metres above mean sea level. The mean annual rainfall in the region is about 650 mm and the area lies in the heart of Western Uttar Pradesh. During the crop period, minimum, maximum temperature and mean relative humidity ranged from 4.6 to 22.7 ^{0}C, 16.5 to 40.2^{0}C and 42.9 to 83.0% respectively with 22.4 mm of rainfall. Twenty treatments consisting of 04 intercropping systems *viz.*, Chickpea + mustard in 3:1 and 4:1 row ratio and both in additive and replacement series along with 05 nutrient management options *viz.*, recommended dose (RD) to chickpea and mustard both (N_1), N_1 + biofertilizers (N_2), N_2 +FYM (N_3), N_1 but mustard with 150% RD (N_4) and N_4 with biofertilizers (N_5) along with sole stand of component crops tested in randomized block design with 3 replications.

2.2 Site description

The experimental field was well drained, sandy loam in texture and slightly alkaline in reaction. Soil was low in organic carbon & available nitrogen, whereas medium in available phosphorus & potassium with electrical conductivity and bulk density of 1.63 dS/m and 1.36 Mg/m^3, respectively. Recommended doses were 100 kg DAP +20kg S ha^{-1} for chickpea and 120 kg N +40 kg P_2O_5 +20 kg S for mustard. Nutrient application to mustard was made as per population against sole stand. Chickpea seeds were inoculated with *Rhizobium* and mustard with *Azotobacter* while PSB was soil applied. Chickpea variety BGM 547 and mustard variety Kranti were sown on 25th of October 2017 and harvested on 14th of March and 30th of April 2018, respectively. Seeds were sown manually in line at a depth of 8 cm for chickpea and 4 cm for mustard. The row to row and plant to plant spacing for chickpea was 30 cm and 15 cm while in case of mustard the spacing varied according to intercropping situation. Irrigation was provided as per need of crop. Crop were kept weed free by regular hand weeding.

2.3 Data collection

Observations on plant height, number of branches plant^{-1} and dry matter accumulation in mustard were recorded at 30, 60, 90 and 120 DAS while nutrient content & yield attributes were recorded at harvest of mustard. Grain and straw yield were estimated based on produce obtained from the net plot area of each treatment.

2.4 Plant sampling and analysis

Post harvest, the sample plants were drawn for estimation of nitrogen, phosphorous and potassium content in grain and straw of mustard. The grain and straw samples were dried at a temperature of 70 °C in hot air oven and dried samples were ground in a stainless steel Thomas Model 4 Wiley Mill. The nitrogen, phosphorous and potassium content in grain and straw of mustard was determined by digesting the samples in a di-acid mixture of HNO_3:$HClO_4$ in a ratio of 3:1 (Page, 1982) using a Kjeltec™ 8000 auto analyzer (FOSS Company, Denmark). Following this, protein content in mustard was obtained by multiplying the nitrogen content of grain with 5.73 and thereafter calculated protein yield by multiplying protein content with grain yield (q/ha). Phosphorous content in grain and straw was determined by vanadomolybdo phosphoric acid yellow color method and potassium content was recorded using flame photometric method (Page, 1982).

2.5 Statistical analysis

The data on growth, yield, nutrient and protein content were recorded as per the standard procedure. The data obtained were subjected to statistical analysis as outlined by Gomez and Gomez (1984) [7]. The treatment differences were tested by using “F” test and critical differences (at 5 per cent probability).

3. Results and Discussion

3.1 Plant height (cm)

In general, shorter plants of mustard were measured at various crop growth stages in different intercropping row ratios over sole cropping. Due to small height of chickpea plants, mustard faced less competition for space and light, resulting in more horizontal growth in intercropping while in sole cropping mustard plants struggled with high competition for space and sunlight, ultimately attaining more plant height. Among intercropping treatments, mustard plants attained more height when grown under chickpea + mustard 3:1 additive series which was at par with respective 4:1 additive and significantly superior over chickpea + mustard 3:1 and 4:1 replacement series. In a field trial conducted by Dhingra *et al.*, (1990) [6], they observed that plant height of mustard decreased significantly when intercropped with chickpea than its sole cropping whereas, the plant height of chickpea significantly increased in intercropping systems. Similar results were given by Prasad *et al.*, (2001) [14].

Taller plants of mustard were measured in sole cropping against all nutrient management options. Among nutrient management options, mustard plants attained taller height with nutrient dose of 150% RDF in mustard treated with *Azotobacter* + 100% RDF in chickpea treated with *Rhizobium* along with soil application of PSB. This treatment was significantly superior over rest of the nutrient management options. Chickpea and mustard treatment with *Rhizobium* and *Azotobacter* along with soil application of PSB, improved the fertility status by increasing the mineralisable nitrogen and available phosphorous in the soil. Similar results were reported by Arya and Jain (2003) [3].

3.2 Number of branches

Intercropping had pronounced effect on the number of branches in mustard at 60 and 90 DAS. Higher number of branches was recorded in chickpea + mustard 4:1 replacement series in comparison to sole mustard and other intercropping treatments. This was possibly due to less plant stand and appropriate row to row spacing of chickpea and mustard in replacement series with low competition for available resources i.e. space, water, sunlight and nutrients. This ultimately led to more horizontal growth of mustard in intercropping system, attaining higher number of branches. Similar results were reported by Kumar and Singh (1987) [8], who found that intercropped mustard had higher number of branches plant^{-1} in chickpea + mustard intercropping with 3:1 or 4:1 row ratio as compared to sole stand.

More number of branches was registered with nutrient management option of 150% RDF in mustard inoculated with *Azotobacter* + 100% RDF in chickpea inoculated with *Rhizobium* along with soil application of PSB, which was significantly higher than the crop receiving 100% RDF alone or in combination with *Azotobacter* and PSB. Increase in number of branches could be attributed to incremental fertilizer doses, i.e. 150% RDF in mustard as per plant population along with *Azotobacter* inoculation. In a field experiment by Tomer *et al.*, (1997) [19], they noticed that nitrogen levels increased the branches plant^{-1} with increase in the levels of nitrogen up to 120 kg/ha. Similarly, Singh *et al*., (1998) [18] observed that application of increasing fertilizer levels up to 120:60:10 kg NPZn ha^{-1} to mustard significantly increased the plant height and branches. Similar results were reported by Kumar and Singh (2006) [7], and Arya *et al*., (2007) [4].

3.3 Dry matter accumulation (g/0.5 m row length)

Dry matter accumulation in mustard differed significantly among different intercropping systems at all the growth stages. Accumulation of dry matter was highest between 60 and 90 days stage. Greatest accumulation of dry matter in mustard was noted in chickpea+ mustard 4:1 replacement series over sole cropping and other intercropping treatments. Significantly, lower dry matter was obtained in chickpea+ mustard 3:1 additive series being at par with respective 4:1 additive and inferior to chickpea + mustard 4:1 and 3:1 replacement series.

Integrated nutrient management option of 150% RDF in mustard treated with *Azotobacter* + 100% RDF in chickpea treated with *Rhizobium* and soil applied PSB, recorded highest dry matter in mustard which was at par with similar nutrient dose without biofertilizers, while superior over rest of the nutrient management options and sole cropping. Application of recommended dose of fertilizers to chickpea and mustard resulted in lowest dry matter accumulation in mustard. In a field research conducted by Tomer *et al.*, (1997) [19], they revealed that fertilizer application had significant effect on dry matter accumulation plant^{-1} with every increase in the level of nitrogen up to 120 kg/ha. Also, Patel and Shelke (1998) [13] stated that application of 80 kg P_2O_5 and 60 kg S ha^{-1} significantly increased the plant growth of mustard during both the years of experimentation. Similar results were given by Kumar and Singh (1987) [8].

3.4 Yield

3.4.1 Grain yield (q ha^{-1})

Intercropping treatments and nutrient management options had significant affect on grain yield of mustard. Among different intercropping systems, highest yield of mustard was obtained in chickpea + mustard 3:1 additive series which was at par with respective 4:1 and significantly superior over chickpea + mustard 4:1 and 3:1 replacement series. Mandal *et al*., (1991) [10] conducted a research experiment and revealed that intercropping of chickpea + mustard in 2:1 row ratio was more productive than sole cropping at Kalyani (W.B). They further told that mustard seed yield was 12.5 qha^{-1} in pure stand and 8.4 to 9.4 qha^{-1} in intercropping systems. In a similar research by Vyas and Rai (1993) [21] opined that chickpea seed yield decreased under intercropping, whereas mustard seed yield was higher when intercropped in 1:3 row ratios with chickpea. Similar results were observed by Prasad *et al*., (2006) [14] and Ahlawat *et al*., (2005) [2].

With regard to nutrient mgt options, application of 150% RDF in mustard treated with *Azotobacter* + 100% RDF in chickpea treated with *Rhizobium* + PSB recorded higher grain yield over rest of the nutrient doses. Lowest grain yield was obtained with nutrient mgt option of RDF to component crops. Similar results were noted by Kumar and Singh (1987) [8] in their research and revealed that intercropped mustard had higher number of branches and siliquae plant^{-1} in chickpea + mustard intercropping with 3:1 or 4:1 row ratio as compared to sole stand. Also, Singh *et al*., (1997a) [16], they conducted an experiment in U.P. on mustard cv. Varuna and chickpea cv. Pant G114 grown alone or intercropped and given 0-80 kg N and 0-60 kg P_2O_5 ha^{-1}. Application of 80 kg N and 60 kg P_2O_5 ha^{-1}, significantly increased yield attributes and yield of mustard in intercropping with chickpea. Further, Singh *et al*., (1997b) [17] found that nitrogen application up to 80 kg ha^{-1} improved the siliquae plant^{-1}, seeds siliqua^{-1}, seeds weight plant^{-1} and 1000 seed weight. Seed yield of Indian mustard increased significantly up to 80 kg N/ha. Yield recorded due to 40 and 80 kg N was higher by 86.5 and 128.8% over the control.

3.4.2 Straw yield (q ha^{-1})
Straw yield of mustard was significantly affected under different intercropping treatments and nutrient management options. Sole crop of mustard recorded higher straw yield against all intercropping treatments followed by chickpea + mustard 3:1 additive series which was at par with respective 4:1 additive and significantly superior over chickpea + mustard 3:1 and 4:1 replacement series.

Among various nutrient mgt treatments, nutrients dose of 150% RDF in mustard treated with Azotobacter + 100% RDF in chickpea treated with rhizobium + PSB, produced highest straw yield which was at par with same dose to component crops without biofertilizers, and significantly superior over rest of the nutrient management options. The higher grain and straw yield was mainly due to higher dry matter accumulation and also more translocation of photosynthates towards sink. Similar findings were also reported by Chand *et al*., (2004) [5] and Arya *et al*., (2007) [4].

3.5 Nutrient content (%)
3.5.1 Nitrogen content
Intercropping treatments exhibited significant affect on nitrogen content of grain and straw in mustard. However, nutrient management options had non- significant impact on nitrogen content in grain and straw. In general, highest nitrogen content in mustard was obtained in chickpea + mustard 3:1 additive series which was at par with respective 4:1 additive and significantly superior over chickpea + mustard 3:1 and 4:1 replacement series and sole cropping. Among, nutrient management options, application of 150% RDF in mustard treated with *Azotobacter* + 100% RDF in chickpea treated with *Rhizobium* + PSB, recorded highest nitrogen content over rest of the nutrient management options. Lowest nitrogen content in grain and straw of mustard was recorded with RDF to component crops. These findings are in close agreement with the results of Vyas and Rai (1993) [21] and Tripathi *et al*., (2005) [20].

3.5.2 Phosphorous content
Significant affect of intercropping treatments and nutrient management options was observed on phosphorous content of grain and straw in mustard. Highest phosphorous content among intercropping treatments was observed in chickpea + mustard 3:1 additive series which was significantly superior to chickpea + mustard 3:1 and 4:1 replacement series. With respect to nutrient management options, application of 150% RDF in mustard treated with *Azotobacter* + RDF in chickpea treated with *Rhizobium* + PSB as soil applied, registered highest phosphorous content in grain and straw of mustard while lowest was recorded with RDF given to chickpea and mustard. Similar findings were given by Vyas and Rai (1993) [21].

3.5.3 Potassium content
Maximum potassium content in grain and straw of mustard was recorded under chickpea +mustard 3:1 additive series which was at par with chickpea +mustard 4:1 additive and significantly superior over chickpea +mustard 4:1 and 3:1 replacement series. Also, integrated nutrient option of 100% RDF in chickpea inoculated with *Rhizobium* + 150% RDF in mustard inoculated with *Azotobacter* + PSB recorded higher potassium content in grain and straw which was superior over rest of the nutrient management options. Least potassium content was recorded with application of recommended dose of fertilizers in chickpea and mustard.

3.6 Protein content (%)
Protein content varied significantly under different intercropping treatments while nutrient management options had non significant affect on protein content of mustard**.** Between sole v/s intercropping systems, mustard grown in chickpea + mustard 3:1 additive series recorded maximum protein content which was at par with respective 4:1 additive followed by chickpea + mustard 3:1 replacement series, than 4:1 replacement series and sole cropping. With regard to nutrient management options, increase in protein content of mustard was registered with enhanced dose of fertilizer *i.e* 150% RDF in mustard treated with *Azotobacter* + 100% RDF in chickpea treated with *Rhizobium* + PSB, which was at par with similar fertilizer dose without biofertilizers. Lowest protein content was recorded when component crops were fertilized with recommended dose of fertilizer. Similar results were observed by Patel and Shelke (1998) [13] who revealed that application of 80 kg P_2O_5 ha^{-1} and 60 kg S ha^{-1} significantly increased the protein content and oil percent in seed of Indian mustard. Also, Singh *et al*., (1998) [18] observed that application of increased fertilizer levels to mustard significantly enhanced the protein content up to dose of 120 kg N + 60 kg P_2O_5 + 10 kg Zn +90 kg S ha^{-1} during both years.

3.7 Protein yield (kg ha^{-1})
Intercropping treatments and nutrient management options exhibited significant influence on protein yield of mustard. Sole mustard recorded maximum protein yield against all intercropping treatments followed by chickpea + mustard 3:1 additive series which was at par with respective 4:1 additive and superior over chickpea + mustard 4:1 and 3:1 replacement series. Application of increased nutrient dose of 150% RDF in mustard inoculated with *Azotobacter* + 100% RDF in chickpea inoculated with *Rhizobium* + PSB recorded significantly higher protein yield in mustard against all nutrient management options while lowest was recorded with RDF applied in chickpea+ mustard. Similar results were observed by Patel and Shelke (1998) [13] and Singh *et al.*, (1998) [18].

Table 1: Effect of cropping system and nutrient management options on growth attributes and yields of mustard

Treatment	Plant height (cm)	Number of branches plant^{-1}	Dry matter accumulation	Grain yield (qha^{-1})	Straw Yield (qha^{-1})
	At harvest				
Sole Mustard	173.5	17.4	125.5	16.9	44.9
Cropping system					
Chickpea + mustard (3:1 A)	163.6	13.3	101.7	9.1	29.3
Chickpea + mustard (4:1 A)	160.5	14.4	103.9	8.7	28.3
Chickpea + mustard (3:1 R)	136.2	17.1	124.9	7.9	25.3
Chickpea + mustard (4:1 R)	134.5	17.7	128.3	7.4	24.2

SEm ±		3.29	0.3	2.55	0.13	0.43
CD (P=0.05)		9.44	1.00	7.30	0.38	1.22
Nutrient Management Options						
Chickpea	Mustard					
RDF	RDF	146.2	14.7	111.3	7.7	25.6
RDF + Rhizo.	RDF + Azato.	147.9	15.4	113.7	8.1	26.5
PSB						
RDF + Rhizo.	RDF + Azato.	148.2	15.5	114.3	8.2	26.7
PSB +FYM						
RDF	150% RDF	150.1	15.9	116.4	8.7	27.3
RDF + Rhizo.	150% RDF + Azato.	151.3	16.5	117.9	8.7	27.8
PSB						
SEm ±		3.68	0.39	2.8	0.15	0.48
CD (P=0.05)		NS	1.12	NS	0.42	1.36

Table 2: Effect of cropping system and nutrient management options on nutrient content and quality of mustard

Treatments		**Nutrient content (%)**						**Protein content (%)**	**Protein yield (kg ha^{-1})**
		Nitrogen		**Phosphorous**		**Potassium**			
		Grain	**Straw**	**Grain**	**Straw**	**Grain**	**Straw**		
Sole mustard		3.2	1.5	0.5	0.3	1.5	1.6	20.3	344.5
Cropping system									
Chickpea + mustard (3:1 A)		3.3	1.5	0.5	0.3	1.6	1.7	20.8	190.3
Chickpea + mustard (4:1 A)		3.2	1.5	0.5	0.3	1.5	1.5	20.4	179.0
Chickpea + mustard (3:1 R)		2.7	1.3	0.5	0.2	1.3	1.5	17.4	139.9
Chickpea + mustard (4:1 R)		2.6	1.2	0.4	0.2	1.2	1.4	16.6	123.9
S.Em.±		0.05	0.02	0.008	0.004	0.015	0.017	0.30	5.09
CD (P=0.05)		0.14	0.06	0.024	0.010	0.045	0.049	0.86	14.57
Nutrient Management Options									
Chickpea	Mustard								
RDF	RDF	2.9	1.3	0.4	0.2	1.3	1.3	18.1	141.9
RDF + Rhizo.	RDF + Azato.	2.9	1.4	0.5	0.3	1.4	1.5	18.6	153.5
PSB									
RDF + Rhizo.	RDF + Azato.	3.0	1.4	0.5	0.3	1.4	1.5	18.7	156.6
PSB +FYM									
RDF	150% RDF	3.0	1.4	0.5	0.3	1.1	1.6	19.1	168.6
RDF + Rhizo.	150% RDF + Azato.	3.1	1.4	0.5	0.3	1.5	1.7	19.4	170.9
PSB									
S.Em.±		0.05	0.03	0.009	0.004	0.017	0.019	0.33	5.69

4. Conclusion

Based on above findings it can be concluded that mustard raised in 4:1 additive series with chickpea proved to be beneficial in obtaining maximum growth, yield and quality with application of 100 kg DAP +20kg S ha^{-1} to chickpea inoculated with *Rhizobium* and 30 kg N, 10 kg P_2O_5& 5 kg S ha^{-1} to mustard inoculated with *Azotobacter* along with PSB as soil applied. On the basis of foregoing findings, it remains no more obscure that chickpea performed individually better in sole stand while mustard in intercropping systems. Consequently, further research is needed with more diversified cropping system for better know how of crop compatibility in different row ratios under various nutrient management strategies to increase land use efficiency and enhance crop production.

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