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Yield Performance of Rapeseed and Mustard under Rice Fallow Situation as Influenced by Varieties and Integrated Nutrient Management Practices

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ABSTRACT

A field experiment was conducted during the *rabi* season of 2019-20 to study the effect of varieties and integrated nutrient management (INM) practices on the yield attributing characters, seed yield, oil content and oil yield of rapeseed and mustard under rice fallow situation. The experiment was laid out in a split plot design with three mustard varieties *viz.*, PM 26 (V_1), PM 27 (V_2), NRCHB-101 (V_3) along with one rapeseed variety *viz.*,TS-36 (V_4) in the main plot and five INM practices *viz.*, control (No N-P-K) (F_1), 50% of the recommended dose (RD) of NPK + vermicompost (VC) @1t/ha (incubated with *Azotobacter* and PSB @ 0.2% w/w for 15 days) in equal splits applied at basal and 30 DAS (F_2), VC @ 2t/ha enriched with biofertilizers (*Azotobacter* + PSB) incubated @ 0.2% w/w for 15 days (F_3), FYM @ 2t/ha (incubated with *Azotobacter* and PSB @ 0.2% w/w for 15 days) + quick lime @ 20 kg/ha + ash @ 2 kg/ha at basal and 30 DAS (1000:10:1) (F_4) and recommended NPK @ 40-35-15 kg/ha (F_5) in the sub-plots and replicated thrice. Results revealed that the mustard variety PM 27 (V_2) was significantly superior with respect to yield attributing characters, seed yield, seed oil content and oil yield followed by NRCHB 101 (V_3) and also application of recommended NPK @ 40-35-15 kg ha^{-1} (F_5) was significantly superior and *at par* with 50% RD of NPK + VC @ 1t ha^{-1} (incubated with *Azotobacter* and PSB) (F_2) in equal splits as basal and at 30 DAS.

***Key words**: Integrated nutrient management, Mustard, Rapeseed, Varieties, Rice fallow.*

Introduction

Rapeseed and Mustard are among the most important edible oilseed crops of India. India produces around 6.9 mt of rapeseed-mustard with significant contribution in world mustard industry (Anonymous, 2014). By 2050, India needs to produce 17.84 mt of vegetable oils for its nutritional fat requirement of projected 1685 million population, but this target will be difficult to achieve with the use of current level of technology and resource management in Indian agriculture (Hedge, 2012). Thus, enhancing the productivity of oilseeds is imperative for self-reliance. Rice fallow areas are those *kharif* paddy growing areas that were kept fallow in *rabi* season and main reasons for leaving these lands fallow during the winter season are lack of irrigation, late harvesting of long–duration high yielding rice varieties, moisture stress at the time of sowing *rabi* crops due to early withdrawal of monsoon, waterlogging and excessive moisture stress in November/December, and nuisance like stray cattle (Ali and Kumar, 2009). Efficient utilization of these fallow lands may improve productivity and sustainability of the regions.

In Assam, rapeseed and mustard is of prime importance and is predominantly grown in the *rabi* season, however, its average yield in most of the areas in the state is still extremely low as compared to that of other parts of the country which may be due to poor soil fertility and nutrient management practices, use of low yield potential varieties and growing situation under rainfed condition. Therefore, identification of the critical inputs to enhance the rapeseed and mustard production is need of the hour. The use of early maturing high yielding mustard varieties for cropping especially in rice fallow may also serve as an effective approach to increase yield. On the other hand, effort should be made to improve the soil health condition through integrated nutrient management (INM) in rice fallows. Through INM, the potential of organic manures, composts, crop residues, agricultural wastes, biofertilizers must be exploited and their synergistic effect with chemical fertilizers made use for increasing the balanced nutrient supply thus, increasing productivity, sustainability of agriculture, and improving soil health and environment safety. Since the use of INM practices in rapeseed and mustard for increasing yield under rice fallow system is essential for achieving self reliance in oilseed production, this study was designed to evaluate the performance of early maturing mustard varieties and the effect of INM in rice fallow situation.

Materials and Methods

A field experiment was conducted during the *rabi* season of 2019-20 at Assam Agricultural University, Jorhat. The experiment was laid out in a split-plot design and replicated thrice. The soil condition of the experimental site was found to be sandy loam in texture, acidic in soil reaction (5.99), high in organic carbon (0.89%), low in available N (219.1 kg ha^{-1}), low in available P_2O_5 (17.4 kg ha^{-1}) and medium in available K_2O (281.8 kg ha^{-1}). Four rapeseed and mustard varieties used were PM 26 (V_1), PM 27 (V_2), NRCHB-101 (V_3) and TS-36 (V_4) in the main plot and five INM practices *viz*., control (No N-P-K) (F_1), 50% of the recommended dose (RD) of NPK + VC @1t ha^{-1} (incubated with *Azotobacter* and PSB @ 0.2% w/w for 15 days) in equal splits applied at basal and 30 DAS (F_2), VC @ 2t ha^{-1} incubated with *Azotobacter* and PSB @ 0.2% w/w for 15 days (F_3), FYM @ 2t ha^{-1} (incubated with *Azotobacter* and PSB @ 0.2% w/w for 15 days) + quick lime @ 20 kg ha^{-1} + ash @ 2kg ha^{-1} at basal and 30 DAS (1000:10:1) (F_4) and recommended NPK @ 40-35-15 kg ha^{-1} (F_5) were alloted in the sub-plots. The crop was sown on 23rd Nov 2019 and rapeseed was harvested on 24th Feb 2020 and on 6th March 2020 mustard was harvested. From each plot, yield attributing characters were recorded and mean was taken. The seed yield was recorded and expressed in q ha^{-1}. The seed oil content (%) was estimated using "Socs-plus" apparatus as per the method described by AOAC (1960) and oil yield was calculated and expressed in kg ha^{-1}.

Results and Discussion

Effect of varieties on yield attributing characters

From the experiment, it was found that the yield attributing characters like plant height, number of primary branches per plant, number of secondary branches per plant, number of siliquae per plant, number of seeds per siliquae and 1000-seed weight were significantly superior in the mustard variety PM 27 (V_2) (Table 1). This may be due to its tall height with profuse branching and high siliquae density with very long main shoot. Yadava *et al*., 2011 also reported similar findings.

Effect of varieties on seed yield

Among four varieties tested, significantly higher seed yield was produced by variety PM 27 (V_2) which was *at par* with NRCHB 101 (V_3) (Table 2). This may probably be due to more profuse vegetative growth, superior yield attributes, more nutrient uptake, better light interception and more partitioning of dry matter towards the economic parts. Moreover, production of higher yield by different varieties might be due to the contribution of cumulative favourable effects of the crop characteristics *viz.*, number of branches per plant, siliquae per plant and seeds per siliquae as reported by Meena *et al.* (2013). Also, yield variation among the mustard cultivars may be attributed to the genetic make-up and environmental effect (Khajuria *et al*., 2017).

Effect of varieties on seed oil content and oil yield

The variety PM 27 (V_2) produced the highest oil yield (Table 2) which may be due to higher capacity to utilize the photosynthates more efficiently in this variety thus, resulting in higher values of yield attributing characters as well as higher yield and similarly more oil content was found in the mustard variety PM 27 (V_2). Similar results were also reported by Saha *et al*. (2015).

Effect of INM practices on yield attributing characters

The highest values of yield attributing characters could be recorded for the treatment with recommended NPK @ 40-35-15 kg ha^{-1} (F_5) which was *at par* with 50% RD of NPK + VC @ 1t ha^{-1} (incubated with *Azotobacter* and PSB) in equal splits as basal and at 30 DAS (F_2) (Table 1). The superiority of F_5 may be due to the supply of nutrients in readily available form through fertilizer source with respect to the treatment with recommended dose to the plants which was applied in optimum amounts. Mishra and Giri (2004) also found similar results. In case of F_2, there might be increased availability of nutrients in the soil and improvement in physical condition of soil resulting from addition of organic manures in the form of vermicompost and in addition, the application of nutrients from both organic and inorganic sources might have provided both macro and micro nutrients thus, supplying nutrients to the plants in optimum amount and at the right time. Pati and Mahapatra (2015) also observed similar results.

Effect of INM practices on seed yield, seed oil content and oil yield

The highest seed yield was recorded for the treatment with recommended dose of NPK @ 40-35-15 kg ha^{-1} (F_5) which was *at par* with application of 50% RD of NPK + VC @ 1t ha^{-1} (incubated with *Azotobacter* and PSB) in equal splits as basal and at 30 DAS (F_2) (Table 2). This may be attributed to the higher values of yield attributing characters in F_5 and F_2 leading to higher seed yield in these treatments. The application of nitrogen (N) at recommended dose in F_5 supplied the needed N at right time because of easy availability from fertilizer

Table 1. Effect of varieties (V) and INM practices (F) on yield attributing characters

Treatments	Plant Height (cm)			No. of primary branch	No. of secondary branch	No. of siliquae plant^{-1}	No. of seeds siliquae^{-1}	1000- seed weight (g)
	30 DAS	60 DAS	90 DAS					
Varieties(V)								
V_1: PM 26	20.92	139.37	165.33	5.27	5.67	146.67	14.53	5.19
V_2: PM 27	22.17	143.93	173.01	6.00	6.87	163.00	15.07	5.53
V_3: NRCHB 101	21.33	141.13	167.40	5.87	6.00	152.13	14.93	5.67
V_4: TS-36	28.57	120.00	112.67	4.13	5.13	79.87	18.67	3.65
S.Em(±)	0.97	1.25	1.98	0.12	0.13	3.51	0.53	0.16
C.D. (P=0.05)	3.37	4.34	6.85	0.43	0.46	12.16	1.82	0.57
Integrated nutrient management (F)								
F_1: Control (No N-P-K)	18.60	113.83	139.46	4.58	5.08	120.08	14.00	4.65
F_2: 50% RD of NPK + VC@1t ha^{-1} incubated with *Azotobacter* and PSB (basal and 30 DAS)	25.83	143.15	159.27	5.67	6.25	141.33	16.50	5.20
F_3: VC@2t ha^{-1} incubated with *Azotobacter* and PSB	23.21	140.05	156.17	5.25	6.08	131.83	15.83	4.89
F_4: FYM@2t ha^{-1} (incubated with *Azotobacter* and PSB) +lime@20kg ha^{-1} + ash @2kg ha^{-1} (1000:10:1) (basal and 30 DAS)	21.25	137.67	154.08	5.00	5.50	131.42	15.67	4.98
F_5: Recommended NPK (40-35-15 kg ha^{-1})	27.35	145.83	164.04	6.08	6.67	152.42	17.00	5.32
S.Em(±)	0.88	2.35	2.33	0.20	0.22	4.51	0.64	0.20
C.D.(P=0.05)	2.52	6.77	6.72	0.57	0.63	12.99	1.84	NS
Interaction V x F								
S.Em(±)	1.75	4.70	4.67	0.39	0.44	9.02	1.28	0.39
C.D.(P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS

Table 2. Effect of varieties (V) and INM practices (F) on seed yield (q ha^{-1}), seed oil content (%) and oil yield (kg ha^{-1})

Treatments (q ha^{-1})	Seed yield content (%)	Seed oil (kg ha^{-1})	Oil yield
Varieties(V)			
V_1: PM 26	10.96	37.59	414.15
V_2: PM 27	11.72	40.31	475.65
V_3: NRCHB 101	11.25	38.33	434.11
V_4: TS-36	9.30	36.03	337.22
S.Em(±)	0.31	1.01	3.43
C.D. (P=0.05)	1.07	NS	11.86
Integrated nutrient management (F)			
F_1: Control (No N-P-K)	7.77	34.53	268.10
F_2: 50% RD of NPK +VC@1t ha^{-1} incubated with *Azotobacter* and PSB (basal and 30 DAS)	11.82	39.48	469.23
F_3: VC@2t ha^{-1} incubated with *Azotobacter* and PSB	11.74	38.34	449.91
F_4: FYM@2t ha^{-1} (incubated with *Azotobacter* and PSB) + lime@20kg ha^{-1} + ash @2kg ha^{-1} (1000:10:1) (basal and 30 DAS)	10.70	37.83	405.31
F_5: Recommended NPK (40-35-15 kg ha^{-1})	12.01	40.15	483.86
S.Em(±)	0.32	1.31	7.87
C.D.(P=0.05)	0.93	3.77	22.68
Interaction V x F			
S.Em(±)	0.65	2.62	15.75
C.D.(P=0.05)	NS	NS	NS

source. Ram *et al*., 2013 also found similar results. Highest seed oil content and oil yield (Table 2) were also obtained from treatment F_5 which may be due to increase in supply of essential nutrients to rapeseed-mustard where their availability, acquisition, mobilization and influx into the plant tissues had increased at perfect synchrony with the critical stages of the crop and thus, improved their oil content and yield. The oil content of mustard crop also responded and showed efficiency for gaining maximum oil content with the application of higher fertilizer doses as reported by Oad *et al*. (2001). They also reported that oil yield depends on the seed yield and were significantly influenced by N application.

From the results of the study, it can be inferred that the Indian mustard variety PM 27 or NRCHB 101 and application of recommended NPK @40-35-15 kg ha^{-1} or otherwise application of 50% RD of NPK + VC @ 1t ha^{-1} (incubated with *Azotobacter* and PSB) in equal splits as basal and at 30 DAS was effective in increasing the yield of rapeseed and mustard under rice fallow situation in Assam. However, considering the importance of INM practice, instead of chemical fertilizer alone, the best INM practice according to this experiment i.e., 50% RD of NPK + VC @ 1t ha^{-1} (incubated with *Azotobacter* and PSB) in equal splits as basal and at 30 DAS may be adopted.

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