The Andhra Agric. J 65 (4): 806-810, 2018

Agronomic Interventions for Enhancing Productivity of Mustard in Rice-Fallows

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ABSTRACT

Afield experiment was conducted during *rabi*, 2017-2018 on clay soils of Agricultural College Farm, Bapatla. The treatments comprised of four seed rates (6 kg ha^{-1}, 8 kg ha^{-1}, 10 kg ha^{-1} and 12 kg ha^{-1}) allotted to factor-A and three varieties (NPJ-112, PM-28, Pusa bold) allotted to factor-B and laid out in factorial randomized block design and replicated thrice. The experimental results revealed that significantly the highest plant height (113.0 cm), more drymatter accumulation (2059 kg ha^{-1}), seed yield (650 kg ha^{-1}), stalk yield (1450 kg ha^{-1}) was recorded in seed rate treatment 12 kg ha^{-1}. More number of branches per plant (7), siliquae per plant (44), seeds per siliquae (11) was recorded with the seed rate 6 kg ha^{-1}. Variety PM-28 significantly recorded tallest plants (110.1 cm), more drymatter accumulation(1992 kg ha^{-1}), more number of branches (6), seed yield (665 kg ha^{-1}) and stalk yield (1652 kg ha^{-1}).

Key words: *Mustard, Seed rates, Varieties*

Mustard (*Brassica juncea* L.) is the third important oilseed crop in the world after soybean and oil palm. The share of oilseeds is 14.1% out of the total cropped area in India and rapeseed-mustard accounts for 3% of it. Among the seven edible oilseeds cultivated in India, rapeseed-mustard contributes 28.6% in the total production of oilseeds. In India, it is the second most important edible oilseed after groundnut sharing 27.8% in the India's oilseed economy. Indian mustard is predominantly cultivated in Rajasthan, U.P., Haryana, Madhya Pradesh, and Gujarat. It is also grown in non-traditional areas of South India including Karnataka, Tamil Nadu, and Andhra Pradesh (Shekhawat *et al.,* 2012). The crop can be raised well both under irrigated and rainfed conditions, and also on residual fertility and residual soil moisture conditions, in rice fallows.

India's annual production of rapeseed and mustard is 6.2 million tonnes in an area of 5.7 million ha with an average productivity of 10.83 q ha^{-1} in 2014-15. In AP, the acerage and production of mustard is 0.6 lakh hectares area and 0.3 lakh tonnes respectively with a productivity of 500 kg ha^{-1} in 2014-15 (http://www.indiastat.com, 2014-15).

MATERIAL AND METHODS

A field trail was carried out on clay soil of Agricultural College Farm, Bapatla during *rabi*, 2017-18.the soil was saline in reaction and low in organic carbon (0.02 %), low in available nitrogen(226.77 kg ha^{-1}), medium in available phosphorus (31.95 kg ha^{-1}) high in available potassium (556.45 kg ha^{-1}) and available sulphur (23.25 kg ha^{-1}). The experiment was laid out in factorial randomized block design and replicated thrice The treatments comprised of four seed rates (S_1 : 6 kg ha^{-1}, S_2 :8 kg ha^{-1}, S_3 :10 kg ha^{-1}, S_4:12 kg ha^{-1}) allotted to factor-A and three varieties (V_1 : NPJ-112, V_2 : PM-28, V_3 : Pusa bold) allotted to factor-B. Mustard was broadcasted before four days of harvesting of rice. The experiment was sown on 01-12-2018 and harvested on 23-02-2018. During the crop growth season climate was nearer to normal. The weekly mean maximum temperatures ranged from 29.94^{0}C to 35.02^{0}C and the weekly mean minimum temperatures ranged from 16.01^{0}C to 19.31^{0}C, respectively with average maximum temperatures of 30.89^{0}C and minimum temperatures of 17.82^{0}C, respectively. The weekly mean relative humidity ranged from 60.80 to 74.65 per cent with an average of 71.33 per cent. No rainfall was received during the entire crop growth period. Overall, the climatic conditions were normal and suitable for the successful cultivation of mustard crop with little incidence of pests which were controlled by suitable insecticidal sprays and there was no disease incidence.

RESULTS AND DISCUSSION

Growth parameters

There was an increase in the initial plant population with increase in the seed rates. All the seed rates tried (*i.e.* 12, 10, 8 and 6 kg ha^{-1}) differed significantly with one another. Significantly the highest (305 plants m^{-2}) plant population was recorded at 12 kg seed ha^{-1} and was followed by 269 at 10 kg ha^{-1}, 202 at 8 kg ha^{-1} and 157 plants m^{-2} at 6 kg seed ha^{-1}. The variation in seed rates ranging from 6-12 kg ha^{-1} resulted in variation in population in different treatments. Similar results were reported by previous workers Brandt (1992), Rahman *et al.,* (2000), Bilgili *et al.,* (2003). Data on plant population indicated that there was no significant difference between the varieties tested. As the test weight in all the varieties used in the experiment was not significantly different there was no significant difference in population per unit area.

At harvest seed rates significantly influenced the plant height (Table 1). Significantly more plant height (113.0 cm) was obtained with the seed rate 12 kg ha^{-1}, which was on par with the seed rate 10 kg ha^{-1}(109.4 cm) and the lowest plant height was obtained with the seed rate 8 kg ha^{-1} (103.2 cm) which was on par with the seed rate 6 kg ha^{-1}(101.2 cm). Taller plants in the plots with high population levels might be due to over crowded plant densities and the inter plant competition that could result in more cell division, cell elongation in search of light and other natural resources Keivanrad and Zandi (2014).

At harvest, significantly more plant height was observed with the variety PM-28 (110.08cm), and was on par with the variety NPJ-112 (108.24cm). The lowest plant height was recorded with the variety Pusa bold (101.89cm). Pusa bold and NPJ-112 were statistically comparable with each other. These are similar with the findings of Fathy and Ahmed (2009), Rashid *et al* (2010), Naseri *et al* (2012) and Patel *et al* (2017).

At harvest, 1417, 1609, 1669 and 1872 kg drymatter per hectare was observed in 6, 8, 10 and 12 kg seed rate ha^{-1}, respectively. At harvest 12 kg ha^{-1} seed rate registered significantly the highest drymatter accumulation whereas the lowest was registered with 6 kg ha^{-1}. The drymatter accumulation got reduced significantly at lower seed rates, Inspite of higher drymatter accumulation plant^{-1} due to less plant population per unit area. At harvest, significantly the highest drymatter accumulation was observed with the variety PM-28 (1979 kg ha^{-1}) and the lowest drymatter accumulation was recorded with the variety Pusa bold (1598 kg ha^{-1}). NPJ-112 variety with 1672 kg ha^{-1} was statistically comparable with Pusa bold. Genotypic growth potential of different varieties might have caused the variations in drymatter accumulation Shanker *et al* (2011).

Maximum number of branches per plant were recorded with the lowest seed rate of 6kg ha^{-1}(6), and it was significantly superior to all other seed rates. The lowest number of branches per plant were recorded in the highest seed rate 12 kg ha^{-1} (5). The higher number of branches per plant in lower densities might be due to lesser competition with in the plants and a sufficient light intensity as a potent source for increasing crop biomass, resulting higher number of branches per plant (Mamum *et al.,* .2014). Significant difference was observed in number of branches per plant due to the varieties. PM-28 (6) recorded the highest number of branches per plant which was on par with NPJ-112 (5). Pusa bold (5) recorded significantly the lowest number of branches per plant. Higher number of branches per plant among varieties is the result of genetic makeup of the crop and environmental conditions which play a remarkable role towards the final seed yield of the crop. Similar varietal difference in terms of number of branches per plant was also reported by the earlier workers, Fathy and Ahmed (2009), Mostofa *et al.,* (2016) and Singh *et al.,* (2017).

Yield attributing characters

There was a significant influence of seed rates on the number of siliquae per plant. Significantly, the highest number of siliquae per plant (43.48) were registered in 6 kg ha^{-1} seed rate and the lowest number of siliquae per plant was (34.91) in 12 kg seed ha^{-1}. 42.9 siliquae per plant with 8 kg seed ha^{-1} and 41.47 siliquae per plant with 10 kg seed rate ha^{-1} were comparable with 6 kg seed ha^{-1}. At higher plant population levels, enough sunlight had not penetrated in to mustard plants due to shading which might have reduced the number of siliquae (Naseri *et al.* 2012, Keivanrad and Zandi 2014). Among the varieties tested, PM-28 registered 43.93 siliquae per plant was significantly superior to the cultivar Pusa bold recording 36.76, the lowest number of siliquae. Cultivar NPJ-112 registering 41.40 siliquae per plant was statistically on a par with PM-28. Number of siliquae per plant is more regulated by to genetic characters of a variety (Shanker *et al.,* 2011 and Singh *et al.,* 2017) (Table 2).

Number of seeds per siliquae differed significantly due to different seed rates. Significantly the highest number of seeds per siliquae (11.69) was obtained with the lowest seed rate of 6 kg ha^{-1} and it was superior to rest of the seed rates. Significantly the lowest number of seeds per siliquae were obtained with the highest seed rate 12 kg ha^{1} (10.34). However, the number of seeds per siliquae registered in the pairs of treatment, 8 kg ha^{-1} and 10 kg ha^{-1} as well as 10 kg ha^{-1} and 12 kg ha^{-1} were statistically comparable. This might be due to competition between plants for growth factors *viz.,* for nutrients and space. Number of seeds per siliquae decreased as plant density increased due to intra and inter plant competition for nutrients. Overall, plant growth, development and final stature would influence total seed setting Mamum *et al.,* 2014). Varieties differed significantly among themselves in this regard. The highest number of seeds per siliquae (12.52) were recorded in PM-28 followed by NPJ-112(11.54). Pusa bold (8.30) registered the lowest number of seeds per siliquae. The varietal difference in several yield attributes may be attributed due to inherent variations in their genetic makeup Khajuria *et al.,* (2017) and Singh *et al.,* (2017) (Table 2)

The 1000 seed weight values registered by 6, 8, 10 and 12 kg ha^{-1} treatments were statistically comparable. 1000 seed weight values 4.44, 4.41, 4.58

Table1. Plant growth characters of mustard as influenced by seed rates and varieties in rice- fallows

Treatment	Initial plant population	Final plant population	Plant height at harvest (cm)	No. of branches per plant	Drymatter accumulation at harvest (kg ha^{-1})
Seed rates (kg ha^{-1})					
S_1 - 6	157	151	101.2	7.00	1558
S_2 - 8	202	194	103.2	6.00	1770
S_3 - 10	269	258	109.4	5.00	1835
S_4- 12	305	293	113.0	5.00	2059
S.Em±	7	6.7	2.67	0.25	97.9
CD (p = 0.05)	20	19	7.8	0.70	287
Varieties					
NPJ-112	233	224	108.2	5.00	1761
PM-28	242	233	110.1	6.00	1992
Pusabold	223	215	101.9	5.00	1663
S.Em±	6.1	5.8	2.31	0.21	84.79
CD (p = 0.05)	NS	NS	6.8	0.60	248
Interaction (S X V)					
S.Em±	12.1	11.6	4.63	0.43	169.58
CD (p = 0.05)	NS	NS	NS	NS	NS
CV (%)	9	10.1	7.5	13.2	15.7

Table 2. Yield attributes and yield of mustard as influenced by different seed rates and varieties in rice-fallows

Treatment	Number of siliquae per plant	Number of seeds per siliquae	1000 seed weight	Seed Yield (kg ha^{-1})	Stalk yield (kg ha^{-1})
Seed rates (kg ha^{-1})					
S_1 - 6	44	11	4.44	565	1300
S_2 - 8	43	11	4.41	577	1346
S_3 - 10	42	10	4.58	601	1395
S_4- 12	35	10	4.5	650	1450
S.Em±	2.2	0.35	0.13	20.18	36.31
CD (p = 0.05)	6.5	1	NS	59	106
Varieties					
NPJ-112	41	11	4.43	618	1287
PM-28	44	12	4.44	665	1652
Pusa bold	37	8	4.59	511	1179
S.Em±	1.91	0.3	0.11	17.47	31.44
CD (p = 0.05)	5.6	0.8	NS	51	92
Interaction (S X V)					
S.Em±	3.83	0.6	0.22	34.95	62.89
CD (p = 0.05)	NS	NS	NS	NS	NS
CV (%)	16.3	9.6	8.7	10.1	7.4

and 4.50 g were registered in 6, 8, 10 and 12 kg seed rate ha^{-1}. Test weight character is more controlled by genetic makeup of the plant and environment and other management practices have a little role to play in influencing the seed weight. All the varieties tested reacted uniformly to influence the 1000 seed weight. 1000 seed weight in Pusa bold (4.59 g), NPJ-112 (4.43 g) and NP-28 (4.44 g) was statistically comparable. Similar reports of non-significant role of seed rates of mustard on test weight was reported by earlier workers Ozer (2003) and Mamum *et al.,* (2014)

Seed and Stalk yield

Mustard seed yield varied significantly due to different seed rates (kg ha^{-1}) tested in the experiment. Significantly, the highest seed yield (650 kg ha^{-1}) was recorded in the treatment receiving 12 kg seed ha^{-1} and was statistically comparable with the seed yield of 601 kg ha^{-1} registered by the treatment received 10 kg ha^{-1} only. The seed yield recorded 601, 577 and 565 kg ha^{-1} in 10 kg ha^{-1}, 8 kg ha^{-1}and 6 kg ha^{-1}, seed rate treatments, respectively were statistically comparable with one another. This might be due to higher nutrient uptake, greater vegetative growth, elevated yield attributes, higher dry matter partitioning towards economic part and better light interception. Yield variability among mustard cultivars also attributed to genetic characters and environmental effects Khajuria *et al.,* (2017).

Seed yield of mustard was also significantly influenced by the varieties under test. Significantly the highest seed yield of 665 kg ha^{-1} was registered by PM-28 variety which was significantly superior to Pusa bold (511 kg ha^{-1}) only and statistically comparable to NPJ-112 with 618 kg seed yield per hectare. Production of higher yield by different varieties might be due to the contribution of cummulative favorable effects of the crop characteristics *viz.,* number of branches per plant, siliquae per plant and seeds per siliquae Shanker *et al* 2011, Pachauri *et al* 2012, Meena *et al.,* 2013 and Mostofa *et al.,* 2016).

Significantly the highest stalk yield was registered in the treatment receiving 12 kg ha^{-1} (1450 kg ha^{-1}) and was significantly superior to the lowest seed rate *i.e.* 6 kg ha^{-1} recording 1300 kg ha^{-1} stalk yield alone. 12 kg seed rate ha^{-1} was statistically comparable with 10 kg seed ha^{-1} (1395 kg ha^{-1}) and 8 kg seed rate ha^{-1} (1346 kg ha^{-1}) (Table 2). The data also indicates that 6, 8 and 10 kg seed rate ha^{-1} also had significantly comparable stalk yields. The highest stalk yield was observed at higher planting density whereas, the lowest was observed at lower planting density. The decrease in stalk yield from higher to lower planting density is mainly attributed to the higher plant population per unit area (Neha *et al.,* 2014). There was a significant influence of varieties on the stalk yield of mustard. All the varieties under test differed significantly with one another. Significantly, the highest stalk yield was registered by PM-28 (1652 kg ha^{-1}) and it was followed by NPJ-112 (1287 kg ha^{-1}). Significantly the lowest stalk yield was registered by Pusa bold with 1179 kg ha^{-1}. This might be due to more plant height, drymatter accumulation and number of branches per plant higher in PM-28 variety and was followed by NPJ-112 variety, (Meena *et al.,* 2013 and Mostofa *et al.,* 2016).

CONCLUSION

It can be concluded that in rice fallow mustard using 10 kg seed rate per hectare was found to be optimum as 10 and 12 kg are statistically at par. Among the varieties PM-28 variety performed better than the remaining two varieties with better growth, yield attributes and yield.

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Received on 18.05.2018 and revised on 08.11.2018