RESEARCH ARTICLE

PERFORMANCE OF SALT TOLERANT MUSTARD VARIETIES UNDER DIFFERENT FERTILITY LEVELS

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Abstract: There is a lack of sufficient research information pertaining to the effect of salt tolerant varieties and varying fertilizer levels on yield of mustard in Haryana. This calls for a need to generate more information on the performance of mustard to different varieties and fertilizer levels. Keeping in views the above facts a field experiment was conducted during Rabi season of 2020-2021 at Research farm of CCSHAU Regional Research Station, Rohtak. The objective of the experiment was to find out optimum fertilizer requirement of salt tolerant mustard varieties. The soil of the experimental field was sandy loam in texture, neutral in reaction, low in organic carbon and available nitrogen, medium in available phosphorus and high in available potassium. The experiment was laid out in Split plot design with four mustard varieties viz. V_1:CS54, V_2: CS58, V_3: CS60 and V_4: RH 725 in main plot and four fertility levels viz. F_1: Control, F_2: 100 % RDF, F_3: 125 % RDF and F_4: 150 % RDF in subplot with three replications. Results revealed that Mustard variety RH 725 took significantly more number of days for flowering and maturity while variety CS 54 took least number of days to flowering and maturity. RH 725 produced significantly taller plants as compared to other varieties whereas; CS 54 produced smallest plants which were at par with CS 58. Similarly mustard variety RH 725 produced significantly more number of primary and secondary branches/plant, siliqua length, number of seeds/siliqua and 1000 seed weight as compared to other varieties. Moreover, RH 725 also produced significantly higher grain; straw and biological yield. Increasing fertility levels from 100% RDF to 150 % RDF delayed the maturity of mustard crop. There was significant increase in plant height, siliqua length, number of seeds/siliqua and 1000 seed weight of mustard with the increasing levels of fertilizers. Application of 150 % RDF being at par with 125% RDF recorded significantly higher grain, straw and biological yield of mustard.

Keywords: Fertility levels, Fertilizers, Mustard, Seed

INTRODUCTION

Mustard (*Brassica spp*.) is one of the important edible oilseed crops across the worldwide. Other than the use of mustard oil for industrial and edible purposes, its cake is a nutritious feed for cattle because of up to 40% protein (Rahman *et al.*, 2018). The maximum area under mustard cultivation is centered in North-West agro-climatic zone, where majority of ground water is highly saline and has medium to high sodicity problems which adversely affects the seed germinability, growth and yield of mustard. Mustard is grown extensively in the arid and semi-arid regions of the world which often experiences saline stress as well. Higher salinity levels reduce the seed germination and seedling growth. There was also reduction in root/ shoot elongation and dry matter accumulation in Indian mustard (Mishra and Anju, 1996). Hence, there is need to enhance crop productivity under saline conditions. Selection of salt tolerant mustard varieties holds great promise in this respect. Therefore it is of great need to develop salt tolerant genotypes of Indian mustard. In this quest, a variety of Indian mustard, CS 60 not only performed better in the All India Salinity Alkalinity Tolerant Variety Trials (AISATVT) in different salinity and alkalinity stress locations in the states of Haryana, Punjab and Uttar Pradesh, but was also adopted by farmers in salt affected areas of the country. CS 60 was recommended for salt affected soils and saline irrigation waters of the country to increase productivity potential of these areas vis-a-vis enhancing the adaptive capacity and improving livelihoods of resource poor farmers against salt stress. It is highly suitable for saline and sodic soil conditions. It yields around 41% oil content even under salt stress conditions. The yield potential in normal soils is 25-29 quintal/ha and in salt affected soils (having pH up to 9.3 and soil salinity upto 9.0 dS/m) is 19-22 quintal/ha.

Nearly, one billion hectares of arid and semi-arid areas of the world are salt-affected and remain barren due to salinity or water scarcity. In India, about 6.75 Mha lands are either sodic or saline in nature and 6.41 Mha land is degraded due to waterlogging. These lands constrain plant growth owing to the osmotic effects of salt, poor physical conditions leading to poor aeration, nutrition imbalances, and toxicities. To meet the requirements of food and other agricultural commodities for the burgeoning population is a big challenge for agricultural community. With the increasing demand for good quality land and water for urbanization and development projects, in future, agriculture will be pushed more and more to the marginal lands and use of poor quality water for irrigation is inevitable. With use of appropriate planting techniques and salt-

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tolerant species, the salt-affected lands can be brought under viable vegetation cover.

Among various edaphic factors, the salt stress and sodicity are important factors limiting the growth and development of plant and result in premature termination of plant cycle. The detrimental effects of salinity are due to the influence of ions on the water activity of the external solution which affects the water status of plant and biochemical functions of the soils (Munns et al., 1982). These effects can result in turgor reduction, inhibition of membrane functions or enzyme activity (WynJones and Gorham, 1983), inhibition of photosynthesis (Walker et al., 1981) or increased use of metabolic energy for non-growth processes involved in the maintenance of tolerance. Hence, better management practices by adopting and counter balance fertilization are essential to increase the yield of mustard under saline water irrigation. The information available on salt tolerance of recently developed mustard genotypes is meager; therefore, present experiment was undertaken with four varieties of mustard at different fertility levels and showed that variation in relation to phenology, growth and yield.

MATERIALS AND METHODS

A field experiment was carried out during *Rabi* season of 2020-2021 at Research farm of Chaudhary Charan Singh Haryana Agricultural University Regional Research Station, Rohtak. The goal of this experiment was to investigate the effect of four different salt tolerant mustard varieties and fertilization on phenology, growth and yield parameters of mustard. The experiment was laid out in Split plot design with four mustard varieties viz.V_1:CS54, V_2: CS58, V_3: CS60 and V_4: RH 725 in main plot and four fertility levels viz. F_1: Control, F_2: 100 % RDF, F_3: 125 % RDF and F_4: 150 % RDF in subplot replicated thrice. The climate of Rohtak (28°40' N latitude and 76° 13' E longitude) is classified as subtropical monsoon, mild and dry winter, hot summer and sub-humid which is mainly dry with very hot summer and cold winter except during monsoon season when moist air of oceanic origin penetrates into the district. The hot weather season starts from mid March to last week of the June followed by the South West monsoon which lasts up to September. The transition period from September to November forms the post monsoon season. The normal annual rainfall in Rohtak district is about 592 mm spread over 23 days. The South West monsoon sets in the last week of June and withdraws towards the end of September and contributes about 84% of the annual rainfall. July and August are the wettest months. 16% of the annual rainfall occurs during the non monsoon months in the wake of thunder storms and western disturbances. The Soil nitrogen and phosphorus status before sowing was 128 kg N and 19.24 kg P_2O_5 ha^{-1} respectively before sowing. Experimental field was prepared thoroughly by ploughings two times and one planking followed by pre-sowing irrigation. Mustard varieties as per treatment were sown on 20th October 2020 and harvested on 22nd March 2021. As per the treatment full dose of phosphorus and half dose of nitrogen were applied as basal dose at the time of sowing and remaining half dose of nitrogen was top dressed. The other agronomic practices from sowing to till the crop harvesting like irrigation, insect-pests control and weed control measures were done as per recommended package of practices of Chaudhary Charan Singh Haryana Agricultural University, Hisar. Data on five randomly selected tagged plants from each plot in each replication were recorded on different quantitative characters viz. Plant height (cm), primary branches/ plant, secondary branches/ plant, siliqua length, seeds/siliqua**,** grain, straw and biological yield (q/ha) and harvest index in all the four fertility treatments. The crop harvested from net plot area was threshed after 5 days of sun drying and the grain yield of net plot was converted into kg ha^{-1}. Before threshing of the harvested crop from net, the sun dried whole plant samples (biological yield) were weighed.

RESULTS AND DISCUSSION

Effect on phenology

The data pertaining to days taken flowering and maturity under different treatments is presented in Table 1. Perusal of data reveals that phenologication variation on days to flowering and physiological maturity of four mustard varieties varied significantly with varying fertility levels. Mustard variety RH 725 took significantly more number of days to attain flowering than rest of the mustard varieties (CS 54, CS 58 and CS 60). Mustard variety CS 54 being at par with variety CS 58 took only 62 days to flowering which is significantly lesser than CS 60 and RH725.Mustard variety CS 54 also took significantly less number of days to attain maturity followed by CS 58, CS 60 and RH 725 respectively. Similar were the findings of Bazzaz *et al.* (2020). Lal *et al.* (2020) also reported that flowering stage in Pusa bold (55.5 days) taken less days compared to other varieties. Among the various mustard varieties RGN-229 taken more days for their completion of life cycle compared to other varieties owing to genotypes characteristics of RGN-229 variety at different phenophases fruit development (91.5 days), physiological maturity (119 days) and harvesting maturity (135 days). The variations in the time taken to reach flowering and maturity by various varieties of mustard might be attributed to the differences in their genetic makeup. This might be due to favourable soil and air temperature during this sowing time which hastened the seed germination and emergence (Gupta *et al.*, 2017). Almost similar findings were reported by Hokmalipour *et al.*, 2011.

Days taken to flowering of mustard were significantly curtailed with the higher doses of fertilizer. Among various fertility levels, days to flowering were significantly less with control (61 DAS) as compared to 100 % RDF, 125 % RDF and 150 % RDF. Days to flowering took significantly higher number of days with the application of 150% RDF followed by 125% RDF and 100% RDF respectively. Days taken to maturity were significantly increased with increasing levels of fertilizers (Table 1). It might be due to reason that days taken to flowering of mustard decreases due to increased growth rate of crop by higher levels of fertilizer application, while days for maturity delays due to application of higher levels of fertilizers resulting in increased vegetative phase. Lal *et al*. (2020) reported that that higher rate of nitrogen application delays flowering. Similarly Bhagchand and Gautam (2000) also concluded that days to flowering and maturity are delayed due to higher doses of fertilizer application. Harfe (2017) also reported that that higher rate of nitrogen application delays flowering.

Effect on growth parameters

The critical analysis of data in Table 1 reveal that growth parameters like plant height, primary and secondary branches/plant and siliqua length of mustard were significantly influenced by varieties and varying fertility levels. Among different mustard varieties, RH 725 produced significantly taller plants as compared to other mustard varieties whereas, CS 54 produced smaller plants which was at par with CS 58. Similarly mustard variety RH 725 also recorded significantly more number of primary branches/plant as compared to other varieties. But, the number of secondary branches/plant were recorded highest in mustard variety CS 60 which was at par with CS 58 but significantly higher than CS 54 and RH 725. The performance of mustard variety CS 54 and CS 58 were at par with each other in terms of plant height, number of primary branches/plant, number of secondary branches/plant and siliqua length. Mustard variety RH 725 outperforms rest three varieties in terms of siliqua length. Better growth parameters in mustard variety RH 725 compared to other three varieties might be attributed to the differences in its genetic makeup. Similar were the findings of Bazzaz *et al*. (2020) who reported significant difference in plant height and branches/plant of three mustard varieties due to various sowing dates and varieties. Among the varieties, the tallest plants were recorded in 'BARI Sarisha-15' and the shortest were in 'Tori-7' regardless of sowing dates.

Application of 150 % RDF being at par with 125% RDF recorded significantly taller plants with higher number of primary branches/plant and siliqua length of mustard. The number of secondary branches/plant were recorded highest with application of 150 % RDF which was at par with 125 % RDF and 100 % RDF but significantly higher than control. All the growth parameters increased with increased fertility levels due to greater availability of nutrients in soil might have enhanced meristematic activity (multiplication and elongation of cells) leading to increased plant height, dry matter accumulation, LAI, CGR and RGR. Maximum plant height (200.3 cm), leaf area index (0.7), crop growth rate (0.046 $g/m^2/day$) and relative growth rate (2.71 mg/g/day) was found with application of 100 kg N + 40 kg P_2O_5 + 30 kg K_2O/ha and lowest with application of 60 kg N + 20 kg P_2O_5 + 0 kg K_2O/ha in mustard by Kumar *et. al*. (2017). Significant improvement in chlorophyll content of leaves might have resulted in better interception and utilization of radiant energy leading to higher photosynthetic rate and finally more accumulation of dry matter by the crop. Our results support the findings of Vivek *et al*. (2009). The rate of increase in plant height was more at lower doses (60:20:0), beyond which it declined, perhaps due to better nutritional environment for plant growth at active vegetative stages as a result of improvement in root growth, cell multipli- cation, elongation and cell expression in the plant body which ultimately increased the plant height.

Effect on yield attributes and yield

Response of mustard varieties to fertilizer application is clearly evident from the data in Table 2. Among the four mustard varieties, RH 725 recorded highest seeds /siliqua and 1000-seed weight of mustard. Because of better yield attributes mustard variety RH 725 also outperforms rest three varieties in terms of grain, straw and biological yield. It recorded grain yield of 3160 kg ha^{-1} which was 65 % higher than CS 54. Similarly harvest index was also reported significantly higher in variety RH 725. These findings are in conformity with Bisht (2004) and Bazzaz *et al*. (2020).

There was significant increase in number of seeds/siliqua and 1000 seed weight of mustard with the increasing levels of fertilizers. Among the four fertility levels significantly higher seeds /siliqua and 1000-seed weight were recorded with application of 150 % RDF which was significantly higher than control and 100 % RDF but at par with 125 % RDF (Table 2). Similarly application of 150 % RDF being at par with 125 % RDF recorded significantly higher grain, straw and biological yield of mustard. Lowest grain and straw yield were recorded with control which was 31.74 and 29.90 % lower than 150 % RDF respectively. It might be due better yield attributing characters of mustard which were also significantly higher with higher levels of fertilizer application. There was 13.48 % increase in biological yield of mustard with the application of 150 % RDF as compared to 100 % RDF. This increase in the yield of mustard may be attributed to the increased plant height, primary and secondary branches, siliqua length and higher seeds /siliqua and 1000-seed weight with 150 % RDF. This might be due to the more availability of nutrient in soil with increasing levels of fertility must have increased the proportion of nutrient in the crop plant which ultimately led to enhance grain and straw yield. Beside this, the higher level of nutrient resulted in higher growth and yield attributes which led to contribute more seed yield. Similar increase in yield due to increasing levels of fertility has also been reported by Ghimire and Bana (2011) and Jat *et al.* (2017). Similar results for grain, straw and biological yield were also reported by Singh *et al.* (2003). Similar were the findings of Bisht (2004). Varying fertility level fail to influence the harvest index of various mustard varieties. Harvest index of various mustard varieties under different fertility levels varies with 23.95 to 24.79 %.

Table 1. Growth of salt tolerant mustard varieties under different fertility levels

Treatments	Days to flowering (DAS)	Days to maturity (DAS)	Plant height (cm)	Primary branches/ plant	Secondary Branches/ plant	Siliqua Length (cm)
Varieties						
V_1: CS 54	62	127	164	6.11	8.16	5.09
V_2: CS 58	63	128	170	6.37	9.25	5.21
V_3: CS 60	65	130	182	7.21	9.47	5.48
V_4: RH 725	68	133	197	8.26	7.74	5.62
CD at 5 %	1.76	1.18	6.23	1.27	1.12	0.18
Fertility levels						
F_1 : Control	61	127	168	5.89	7.16	4.69
F_2 : 100 % RDF	64	129	176	7.19	8.98	5.15
F_3 : 125 % RDF	66	131	183	7.37	9.16	5.67
F_4 : 150 % RDF	67	132	186	7.48	9.32	5.89
C.D. at 5 %	1.76	0.85	5.98	1.24	1.22	0.24

Table 2. Yield attributes and yields of salt tolerant mustard varieties under different fertility levels

Treatments	Seeds/siliqua	1000-Seed weight (g)	Grain yield (kg/ha)	Straw yield (kg/ha)	Biological yield (kg/ha)	Harvest index (%)
Varieties						
V_1: CS 54	12.84	5.12	1915	6286	8201	23.36
V_2: CS 58	13.23	5.28	2094	6429	8523	24.59
V_3: CS 60	13.40	5.51	2361	7922	10283	22.98
V_4: RH 725	13.96	6.95	3160	8993	12153	26.11
CD at 5 %	0.34	1.15	181	194	262	3.70
Fertility levels						
F_1 : Control	12.25	4.98	1877	5828	7705	24.32
F_2 : 100 % RDF	13.45	5.13	2341	7409	9750	23.95
F_3 : 125 % RDF	13.78	6.23	2562	8078	10640	23.98
F_4 : 150 % RDF	13.95	6.52	2750	8315	11065	24.79
C.D. at 5 %	0.36	0.58	206	262	711	NS

CONCLUSION

From the investigation, it can be concluded that among various salt tolerant mustard varieties RH 725 recorded significantly higher grain, straw and biological yield with better growth and yield attributes and application of 150 % RDF being at par with 125 % RDF showed mark improvement in yield attributes and yield of mustard varieties.

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