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Appraisal of new Raya (*Brassica Juncea* L.) Genotypes for Their Suitability in Arid Climatic Conditions

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Abstract

The abrupt and extreme climatic conditions have paved ways for a shift in crop adaptability in their agro-ecological zones. To combat the uncertainty in crop yield, it is prerequisite to test newly developed crop genotypes to specific climatic conditions. Hence a two-year experiment was planned to evaluate the phenotypic performance and genetic potential of grain yield of six locally produced genotypes of Raya (*Brassica juncea L.*). The experiment was conducted at the research farm Regional Agricultural Research Institute, Bahawalpur, Pakistan during 2018-19 to 2019-20. The study was laid out in Randomized complete block design and replicated four times. The observations were recorded for yield and yield determining components and final results showed that variety Bwp-Raya produced maximum grain yield (kg ha^{-1}) as 4856.5 kg/ha due to highest number of silique per branch as 169.25, grains per silique as 18.500 and 1000 grain weight as 4.015g. While among strains Brj-9070 produced maximum grain yield (kg ha^{-1}) as4278 kg/ha due to highest number of silique per branch as 168.50, grains per silique 18.250 and 1000 grain weight. This evaluation was crucial in order to determine the best performing Raya variety in arid conditions, so that farmers can select the best suitable variety according to climatic conditions prevailing in their areas.

Key words: Genotypes, strains, yield potential, silique, agro-ecological zones, arid

Introduction

Raya *(Brassica juncea* L.) being a significant oil seed crop, enjoys a prominent position in the world especially due to its economic importance. It stands as the third most important crop at world level. In Pakistan, it stands at second position after soya bean. in Pakistan total cultivated area is 227.8 hectares, production 209.5 tons with an annual yield of 0.92 tons per hectares (FAOSTAT, 2020). As an economical important crop, Raya contributes its role for raising country GDP and Pakistan has become the major importer of edible oil at world level. Raya has greater adaptability to various set of environmental conditions and also comprised of higher yield potential Raya yield is affected severely by certain biotic and abiotic factors. In this regard, advance breeding practices is becoming successful in releasing certain sets of high yielding genotypes which can withstand the harsh climatic conditions of southern Punjab. It is because, *B juncea* contains diverse germplasm which serves as important factors for attaining genotypes with improved grain yield and oil contents in Raya (Abbas *et al*., 2009). Ashraf and Foolad (2007) also stated that wise selection of germplasm plays critical role in improving yield potential per acre. Determination of yield and yield related components are analysed in various patterns and among them correlation factor is crucial (Shekhawat *et al*., 2014; Kalyar and Salim, 2015). which can provide an inside to the relationship between different yield defining components. Studies on *Brassica napus* and *Brassica juncea* revealed that plant height, no of branches per plant, no of pods/plant and seeds/plant highly correlates to the final grain yield (Larik and Rajput, 2000), however negative correlation is present between grain yield and days to 50% flowering (Shekhawat *et al*., 2014). Moisture deficiency can remarkably affect silique/ plant and oil contents, as at increased irrigations and augmented grain yield was perceived by Tahir *et al*., (2007). The most important factors which governs Raya yield is the seasonal variations. Sowing date determines the final yield fate of Grain yield (Robertson *et al*., 2004). *Brassica juncea* is more drought tolerant in comparison to *B. napus* and *B rapa* hence it has potential for cultivation in arid and semi-arid regions (Singh *et al*., 2013). As during the current climatic scenarios the abrupt dry spans or torrential rains takes place thus disturbing the sowing time and the performance of newly developed genotypes. The purpose of the current study was to determine the yield potential of Raya strains that are locally developed at the research institute so that all aspects of the strains are well studied prior to sowing at farmers' field. Moreover, it is crucial to identify the yield gaps and yield lowering components along with determinations of yield components which are involved in determining yield components. This study will test the hypothesis that i) Various *Brassica juncea* genotypes perform equally under arid conditions and ii) All yield and yield determining parameters are correlated to each other. Hence the testing of advanced genotypes of Raya under agro ecological conditions of southern Punjab is carried out in this experimental study.

Materials and Methods

Experimental site: The experiment was performed at the farm of regional agricultural research institute Bahawalpur, Pakistan during two years i.e. 2018-19 to 2019-20. The site is located at 29.35- degree N and 71.69-degree E and at elevation of 118 m. The area experiences average annual temperature of 26.1 °C.

Treatments and layout plan: Six locally developed raya strains i.e., BRJ-8067, BRJ-9072, BRJ-9070, Brj-1004, BWP-Raya and Khanpur Raya were sown during the second fortnight of October in each year. Crop maintenance work was uniform for all plots and data was observed for further analysis. The experiment was laid out in Randomized complete block design and was replicated four times. The plot size was maintained as 1.8x6m, the plant-to-plant distance was 15 cm whereas line to line distance was maintained as 45cm. **T**he recommended dose of fertilizers as 90-60-60 NPK kg ha^{-1} was applied to the crop. The sources for nitrogen, phosphorus and potassium were urea, diammonium phosphate and sulphate of potash respectively. The irrigations were kept constant for each genotype. First irrigation was applied after 35 days of sowing, second at flowering, third at pod formation and forth was applied during grain filling duration. Thinning was done before first irrigation.

Data collection and statistical analysis: The data regarding Plant population (m^2), plant height (cm), no of branches, plant, no of silique per branch and no of grains per silique were counted manually and noted. Final grain yield(Kg/ha) and 1000 grain weight (g) were also noted. All the data was subjected to statiscal analysis by using the statistical software 'statistix-8.0'. Anova was generated and means of parameters was compared to each other @5% probability level in order to know the significant difference level of each strain/variety (*Steel et al.*, 1997). Moreover correlation was carried out among various yield determining factors by performing association test (pearson correlation) Metrological data was collected on daily basis from climate observatory present near the farm vicinity and presented in Figure 1 and 2 (a, b)

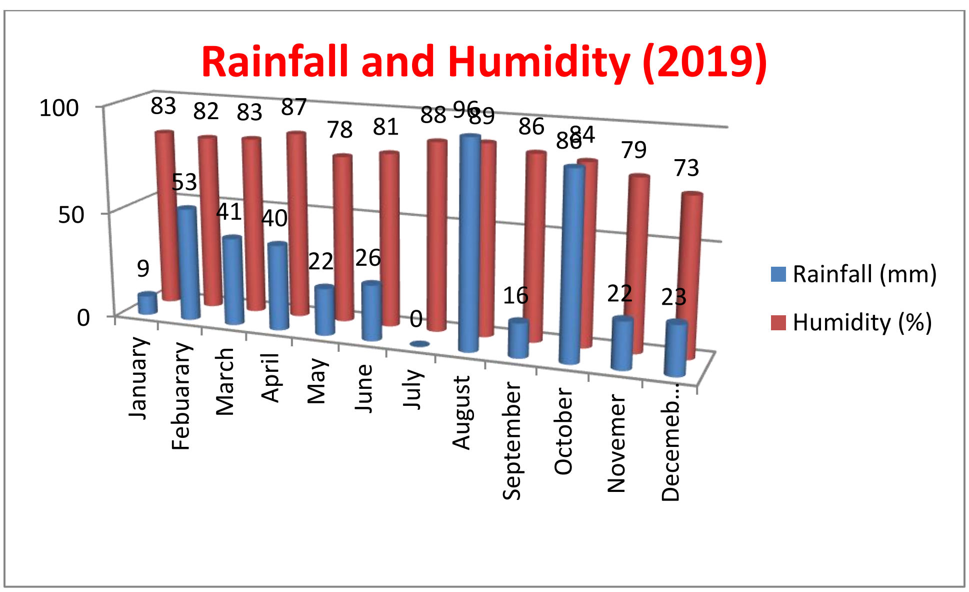

Figure 1a Rainfall (mm) and humidity (%) data during the crop season

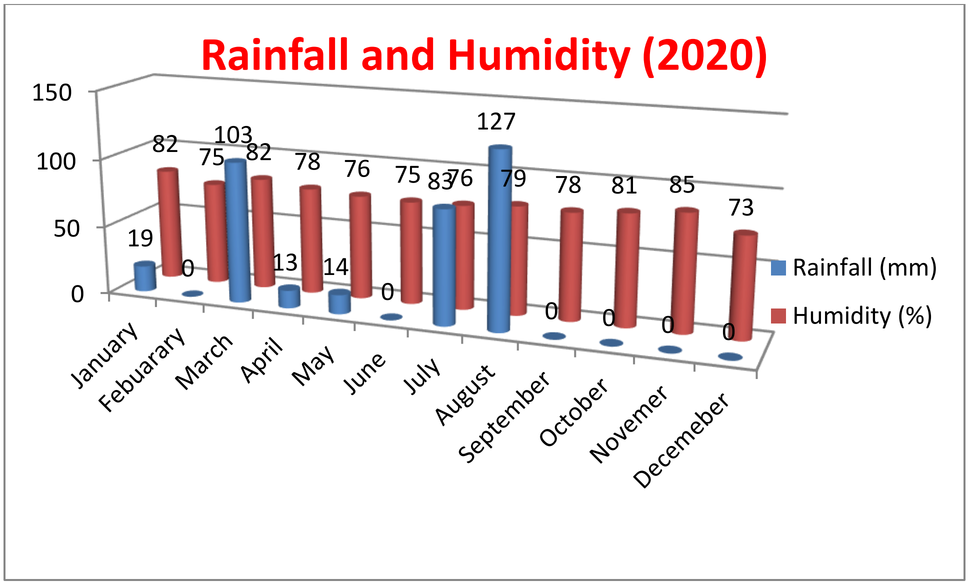

Figure 2b Rainfall (mm) and humidity (%) data during the crop season

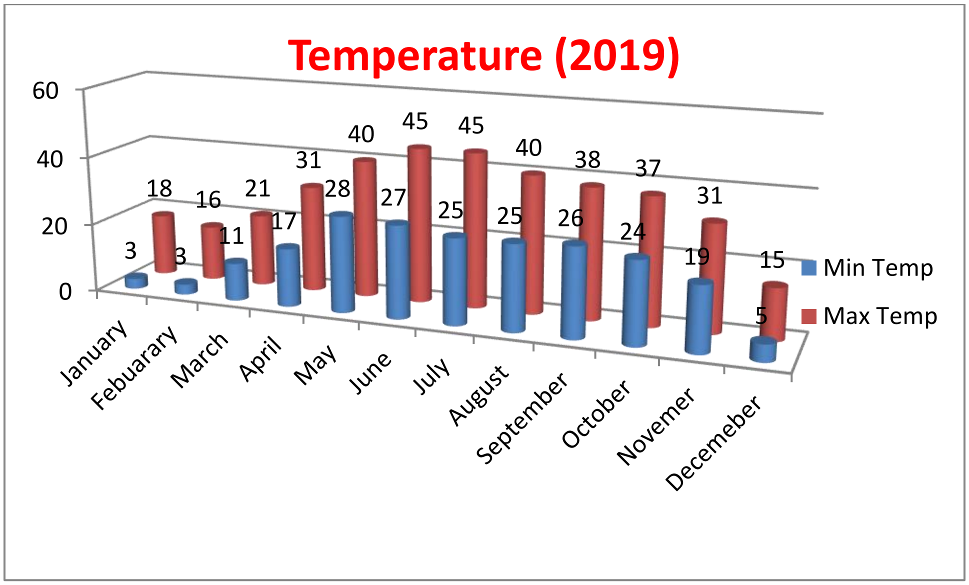

Figure 2a Minimum and Maximum temperature (°C) during the crop season

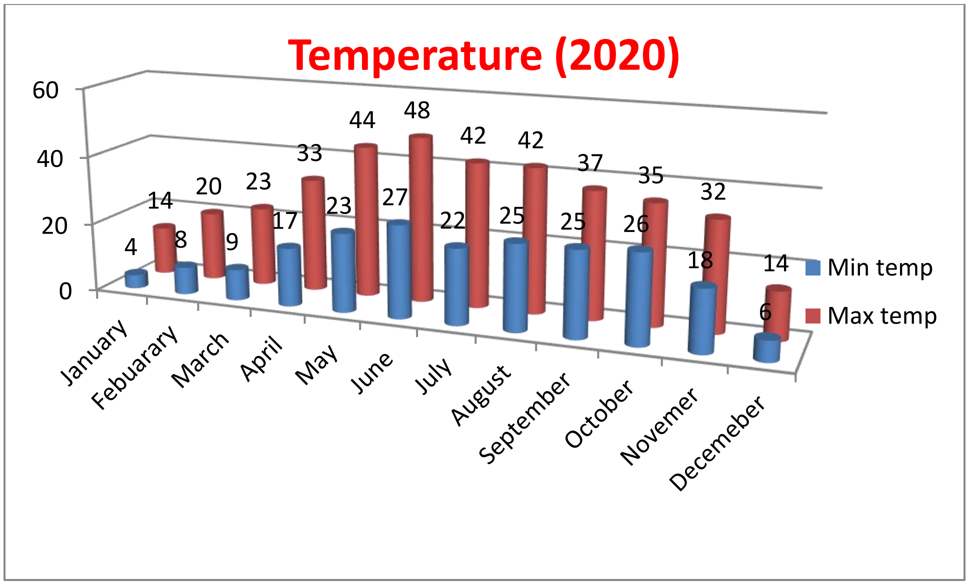

Figure 2b Minimum and Maximum temperature (°C) during the crop season

Results and Discussion

The result of our study revealed germinated uniformly and depicted homogeneity in plant population. Equal plant population is critical factor for determination of final yield as uniform geminated plants get equal chance for survival with regard to nutrient and water availability and their access. Our results are similar to results of Tahir *et al* (2007) who also stated equal or non-significantly different plant population rate in canola. that plant population of all the tested varieties did not differ significantly ($p< 0.05$). It shows that all crops was As far as plant height is concerned, data regarding plant height depicted that all strains differ significantly with each other. Plant height is governed by environment as well as genetic factors. Table 1 shows that BWP-Raya gained maximum plant height (226cm), plant height of Khanpur-Raya was also statistically at par to BWP-Raya and gave a value of 225 cm. BRJ-1004 rendered to be small statured and gave 217cm of plant height. Studies exist in literature that affirms that difference in plant height is attributed to their genetic potential. The variation in plant height may suggest that environmental conditions were not suitable for a certain variety to achieve its maximum height. Previously Lark and Rajput (2000) reported significantly different plant heights in various varieties of *B juncea* and *B napus.* No of branches plays a significant role in determination of final yield. The results of our study (Table 1) revealed that no of branches was statistically not significantly different to each other. these results show that genes present in tested raya strains which controls the no of branches does not differ in such a way that causes a huge difference in branch expansion. The more or less similar no of branches per plant is due to combination of soil, environmental conditions and genetic set up of the plant. However, our results are not in accordance with the previous findings of Sana *et al* (2003) who stated a significant difference in number of branches per plant in B napus plants. Similarly, Tahira *et al* (2011) stated Brassica juncea cultivars can differ in their branch numbers.

Table no. 1 (a): Yield and yield determining components of Raya strains

Genotypes/Varieties	Plant population (m^2)	Plant Height (cm)	No. of Branches per Plant	No. of Silique per Branch
Brj-8067	11.3 a	221.3 ab	13 a	173 a
Brj-9070	11.1 a	222 a	13.5 a	170a
Brj-9072	10.5 a	213 a	14.25 a	168.25 a
Brj-1004	10.5 a	217 b	14.3 a	163.25 b
Bahawalpur-Raya	11.6 a	227 a	13.9 a	170.25 a
Khanpur-Raya	11.85 a	223 a	15.25 a	169 a
LSD Values	0.9229	5.4033	2.5752	4.8941

LSD determined at alpha level 0.05. Means sharing a letter common are not significantly different from each other.

Table no. 1 (b): Yield and yield determining components of Raya strains

Genotypes/Varieties	No. of Grains per Siliqua	1000 Grain's Weight	Yield / Plot	Yield kg / ha
Brj-8067	17 b	3.7 b	4.36 b	4034 b
Brj-9070	19.25 a	3.9 ab	4.61 b	4288.3 b
Brj-9072	18 ab	3.6 ab	4.26 b	3942 b
Brj-1004	18 ab	3.6 ab	4.64 b	4288.3 b
Bahawalpur-Raya	20 a	4.1 a	5.26 a	4866.5 a
Khanpur-Raya	19 a	3.95 a	5.11 a	4820.25a
LSD Values	2.0033	0.2836	0.4206	383.34

Silique per plant is among the key component which determines the final yield in Raya. It is also dependant on the soil type, prevailing environmental conditions and the genetic make-up. The results of this study depicted in table 1 showed that all tested genotypes differ significantly with each other with regard to no of silique per branch. In this case, the highest number of silique were found in BRJ-8067 (171.75) followed by Bahawalpur raya as (169.25). BRJ-1004 gave minimum no of silique per branch as 162.25. Our results showed that agro ecological conditions of Bahawalpur are highly suitable for BRJ-8067 followed by Bahawalpur Raya. Akber *et al* (2007) stated that B. napus and *B. juncea* cultivars significantly differ in no of silique per branch. Brassica grain yield is correlated with the number of grains per silique. As presented in Table no.1, the varietal means of no of grains per silique is significant for most of the genotypes. Bahawalpur-Raya produces maximum number of grains/siliques as 18.500 followed by BRJ-9070 as 18.250. BrJ-8067 gave minimum numbers of grains/silique as 15.500. Our results are in line with previous studies of Sana *et al* (2003) where they also found that canola genotypes differs significantly in their number of grains per silique which ultimately affects final grain yield. Moreover this component is important phenotypic expression of the yield potential. Similarly, Larik and Kumar (2000) studies B juncea and B napus genotypes and reported significantly different no of grains per sillique. Tahira *et al* (2011) carried out a similar study on B juncea and reported similar results to our study. Another important factor that reflects seed yield potential of a variety is its seed weight. Table 1. Show that 1000 grain weight of all studied strains was significantly different with each other. BWP-Raya gave maximum 1000 grain weight as 4.015g while after this Khan Pur raya gave value of 3.937g. As far as strains are concerned, BRJ-1004 yielded minimum as 3.500. BRJ-8067 1000 grain weight was statistically at par to BRJ-1004. Previously studies performed by Hashem *et al* (1998 and Om *et al*., (1998) who stated that significant difference occurs in 1000 grain weight of genotypes in Brassica cultivars. Sana *et al*., (2003) carried out research in canola crop and found that cultivars differ in their grain weight potential according to the genetic set up. Similar results were carried out by Akber (2007) who studied B. juncea and stated differences in 1000 grain weights. The final grain yield is the most important factor which exhibits the potential of any crop. Our results revealed that Bwp raya yielded best as 5.25 kg followed by khanpur raya (5.10 kg). Minimum grain yield was observed in BRJ-9072 as 4.25 kg. The final grain yield of Brassica is dependent on the cumulative effects of different yield components. We also studied the important yield determining components like plant population, no of branches, no of silique, 1000g weight and final grain yield. Bahawalpur raya giving maximum values of yield determining components also yielded best in grain yield as 4856.5 kg/ha, whereas, minimum yield was recorded in BRJ-9072 as 3931.5 kg/ha.

Correlation analysis of various yield determining parameters

Table no. 2 : Yield and yield determining components and coefficient of correlation between them (Pearson correlation) in Raya strains

	Branch/ plant	Grain/ silique	Plant population (m^2)	Plant height (cm)	Silique/ branch	1000 grain wt (g)	Yield/plot (kg)
Grain/ silique	0.317						
Plant population (m^2)	0.162	0.469					
Plant height (cm)	-0.106	0.622	0.867				
Silique/ branch	-0.524	-0.006	0.591	0.487			
1000 grain weight (g)	0.120	0.854	0.834	0.910	0.414		
Yield plot (kg)	0.461	0.804	0.730	0.791	-0.011	0.858	
Yield hac (kg/ha)	0.505	0.794	0.756	0.781	-0.002	0.856	0.996

The correlation coefficients reveal the nature of association between the observed variables Table 3 gives a detailed insight to the R^2 values for all of the observed values. The values near to 2 showed a highly positive relationship between the variables while R^2 value near to -1 represents highly negative correlation between two variables. Grain yield was significantly correlated with grain/silique (0.79), plant population (0.75) and plant height (0.78). Silique/branch was negatively correlated to branch/plant (-0.52) and grain/silique (0.006). Previous research studied correlation between genotypic and phenotypic expressions and showed a positive and direct relation of days to physiological maturity and thousand grain weight (Khayat *et al*., 2012). Seeds/silique was positively correlated with yield (Rameeh, 2011). Whereas sinha *et al*. (2001) reported negative correlation between plant height and yield/plant. The differences between the correlation values in different studies may occur under uncertain climatic conditions, for instance, plant may complete its vegetative growth under suitable environments but a sudden stress (High temperature) shrink the seeds or even disrupt grain formation process.

Conclusion and future recommendations

Conclusively this study found that Bahawalpur Raya can be recommended as the best Raya genotype for the agroecological conditions of Bahawalpur followed by Khanpur raya. The yield confirmation for the studied strain makes it possible for the breeders to identify the most promising line for future and to know the yield gap of the cultivars. Our study affirms the findings of previous researchers that yield determining parameters play critical role in assessing a genotype, however, under unpredictable conditions extensive correlations among phenotypic expressions may act as a useful tool for variety characterization. Furthermore, this study is important for the researchers to recommend varieties for areas which face arid type of climatic conditions.

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