Comparison of Hybrid verses Composite Brassica Varieties for Forage and Seed Yield under Rainfed Conditions of Pothwar

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Abstract: In rainfed farming, livestock is the main source of livelihood as the agriculture crops often confront drought situations and thus may not reach to maturity. Brassica having tape root system has the ability to grow under rainfed conditions. To provide green fodder to livestock during winter fodder scarcity period, an experiment was conducted to compare hybrid brassica with composite brassica varieties for higher forage yield under rainfed conditions of Pothwar. Three hybrid brassica varieties i.e. Hyola-401, Omega-1 Omega-3 and one composite variety Chakwal sarsoon were grown at University Research Farm, Chakwal Road Rawalpindi during 2010-11 in a Randomized Complete Block Design with three replications. Significant difference of forage and seed yield components was recorded between brassica hybrids varieties and Chakwal sarsoon. Maximum fresh and dry weight was produced by brassica hybrid variety Hyola-401 followed by Omega 1 and then Omega 3 while lowest fresh and dry weight was produced by Chakwal Sarsoon under rainfed conditions. The results clearly indicate that the hybrid brassica has more adoptability compare with composite varieties under rainfed conditions of Pothowar. On the basis of these results, Hyola-401 which resulted higher yields of brassica forage and seed under rainfed conditions of Pothwar can be recommended to livestock farmers to grow hybrid brassica to overcome the problem of green fodder during winter fodder scarcity months.
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Keywords: Brassica hybrid vs composite varieties; forage yield; rainfed condition.

1. Introduction

Agriculture is considered to be the backbone of Pakistan economy contributing 21% share in total GDP (Government of Pakistan, 2011). Pakistan has 22 m ha of arable land out of which 4.6 million hectares are rainfed and contributes about 24% in total crop yield of Pakistan (Muhammad and Muhammad, 2007). Pothwar region is considered to be the largest block of rainfed agriculture in Pakistan, which covers 28% of the total rainfed area of the Punjab province (ABAD, 1996). The livestock constitute 55.1 percent of agriculture value addition and about 11.4 percent of the GDP (Government of Pakistan, 2011). The area under fodder crops is 3.4 million hectares out of a total cropped area of 21.9 million hectares in the country, producing more than 60 million tones of fodder which has been reported to be significantly insufficient even to meet the maintenance requirement of the livestock (Anonymous, 2007).

The rural economy of Pakistan is largely associated with forages, their production and feeding to livestock as fodder is 2-3 times cheaper source of nutrition than the costly feeding options of concentrates which is not affordable by the poor farmers of the country especially in rainfed regions. Miller (1984) stated that the forages consumed by the animals make up 80% of the total feed units, while the remaining balance is supplied by concentrates and other by-products.

In rainfed areas, along raising crops, livestock provides economical sustainability to the farmers. In order to support the livestock industry, the role of forages especially during lean period (December-January) is of great significant and needs to be addressed on scientific lines to overcome the fodder scarcity period. Fodders like Barley (*Hordeum vulgare*), Oats (*Avena sativa*), Raya (*Brassica juncea*) and wheat (*Triticum aestivam*) are commonly grown in winter season provided sufficient rain fall and thus providing adequate carbohydrates to livestock. The inadequate availability of green fodder during winter dry months i.e. December- January can be minimized to great extent by growing brassica as a forage crop which is multi-purpose crop, quick growing and can be successfully grown under rainfed conditions of Pothwar, being hardy to moisture stress and tolerant to cold winter temperature. Mustard

(*Brassica napus*), belonging to family Cruciferae, is a widely used crop sown in winter and then fed to livestock under semi-arid conditions of the country. One of the important attributes of the crop is its ability to grow rapidly to produce leafy material within a relatively short time from sowing. It is palatable, succulent and nutritious crop and forms an excellent combination when fed along with dry silage or hay. The crop maintains quality well into freezing temperatures and may be fed in fodder scarcity period. In agro-climatic conditions of Pothwar, it has an important position due to fitting well in rainfed cropping system, mustard commonly intercropped with wheat. This crop is mainly grown in rainfed areas of Pakistan, where water availability is one of the most important limiting factors affecting plant growth and development. Brassica has extensive and deep root system which enables it to thrive under less moisture availability. Soil and climatic conditions of Pothwar are conducive for brassica and thus facilitate to produce plenty of fodder during fodder scarcity period in this region for livestock instead of bringing in green fodder from the other parts of the country. One of the effective ways is to select those cultivars that can yield better in low moisture conditions.

Keeping importance of brassica fodder in view, present study was carried out to identify the hybrid brassica varieties suitable for forage and seed yield in comparison to Chakwal sarsoon that can produce higher tonnage during winter months under rainfed conditions of Pothwar.

2. Material and Methods

The experiment was conducted at PMAS-Arid Agriculture University Research Farm, Chakwal Road Rawalpindi on sandy loam soil having EC of 0.30 and 0.35 $dscm^{-1}$, pH of 7.6 and 7.5, organic matter 0.85 and 0.45%, available phosphorus of 4.7 and 3.5 mg kg^{-1} and available potassium of 120 and 100 mg kg^{-1} from soil depth of 0-15 and 15-30 cm respectively, to evaluate the performance of different brassica hybrids vs Chakwal sarsoon forage and seed yield under rainfed conditions of Pothwar during winter 2010-11.

Daily maximum and minimum temperature (^oC) and rainfall (mm) data collected during the study period is presented in Figure 1.

The experimental treatments consist of three hybrids brassica varieties i.e. Hyola- 401, Omega-1 and Omega-3 were compared with Chakwal sarsoon as check treatment replicated three times in a randomized complete block design.

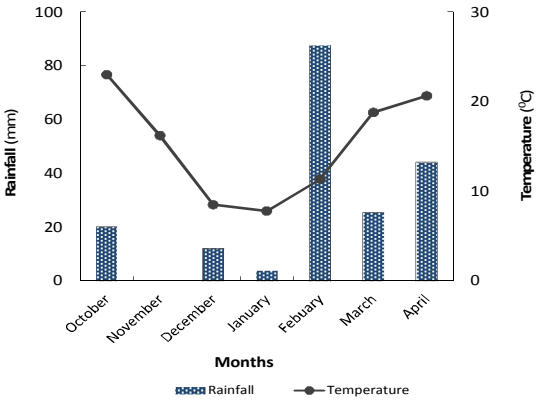

Figure 1: Mean monthly rainfall and temperature during the crop growth period.

The net plot size was 5 x 8 m. Seeds of all the brassica varieties were sown @ 5 kg ha^{-1} with the tractor drawn drill in 45 cm spaced rows. Nitrogen fertilizer @ 90 kg ha^{-1} and phosphorus @ 60 kg ha^{-1} were applied in the form of urea and single super phosphate at the time of seedbed preparation. All other agronomic practices were kept normal and uniform for all the treatments as per recommendation.

At harvesting time ten random guarded plants were taken from each plot in 1 m^2 and the data of plant height, number of branches $plant^{-1}$, fresh and dry biomass traits were recorded. Forage and seed yields were recorded from 1 m^2 and converted into t ha^{-1} and kg ha^{-1}, respectively.

The data were analyzed for analysis of variance using Statistix software. To compare the treatments means, least significance difference test at 5 percent probability level was employed.

3. Results and Discussion

Plant height (cm): To obtain higher yield of the fodders, taller plants are considered paramount important for higher forage yield. In the present study, there is statistically significant difference among the brassica hybrids and Chakwal sarsoon. Data presented (Figure 2A) revealed that there is statistically significant difference of plant height. The maximum plant height of 168.8 cm was obtained by Hyola-401 brassica hybrid, while minimum plant height of 126.2 cm was attained by Chakwal sarsoon. The results of the experiment clearly indicated brassica hybrid that Hyola-401 produced 25 % more taller plants in comparison to Chakwal sarsoon under rainfed conditions. The results are in line with the findings of Khatri *et al.,* (2004), who reported variability of plant height among different brassica genotypes under rainfed conditions. Similarly, El-Nakhlawy and Ahmed (2009) of Sero-4 genotype

produced taller plants in comparison to others composite brassica genotype under different irrigation regimes and nitrogen fertilizer application, respectively. Growth of plant depends on cell expansion and enlargement which is probably the most sensitive physiological aspect of a plant with regard to water deficit leading to reducing plant productivity (Larson, 1992) and thus affects plant height. These results are consistent to Munir (1991) who concluded that plant height of brassica species tended to vary with the precipitation pattern during growing season. Mastro (1995), Reddy and Reddy (1998) and Ozer (2003) reported that different brassica varieties differed significantly with regard to their plant height. Cheema *et al.,* (2001) recorded a range of 178-215 cm of plant height while Sana *et al.,* (2003) recorded 198-229 cm plant height of brassica varieties but in our experiment, a range of 126-169 cm plant height of brassica varieties under rainfed conditions where 194 mm rainfall received during crop growth period.

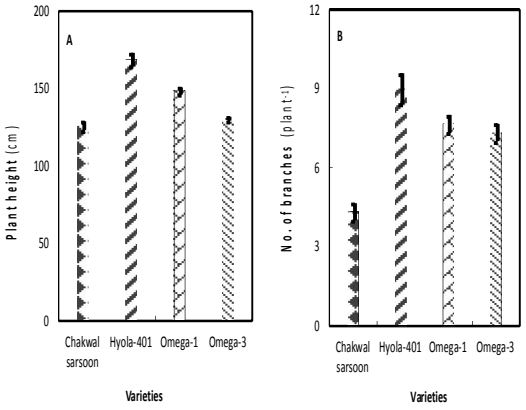

Figure 2: Comparative performance of plant height (A) and number of branches (B) of hybrid and composite brassica varieties grown under rainfed condition during winter 2010-11. Error bar represent the standard

Our plant height is less than the earlier findings; it may be due to their genetic variability or due to different agro- climatic conditions under which brassica varieties tested with respect to other areas.

Number of Branches plant^{-1}: Number of branches plant^{-1} is an important morphological character that influence overall yield. Number of branches plant^{-1} presented in Figure 2B clearly indicated significant difference among the brassica hybrids varieties and Chakwal sarsoon. Maximum number of branches plant^{-1} (9.0) was produced by Hyola-401 brassica hybrid which was at par with Omega-1, whereas the minimum number of branches plant^{-1} (4.3) were recorded by Chakwal sarsoon. A great variation has been observed with regards to brassica branches plant^{-1} Ozer (2003) found a range of 4-5 branches plant^{-1}. Cheema *et al.,* (2001) recorded a range of 14-24 and Sana *et al.,* (2003) 19-29 branches per plant in different brassica genotypes but in our experiment, a range of 4-9 branches per plant was recorded. The difference of number of branches plant^{-1} may be due to the different agro- climatic conditions of Pothwar with respect to other areas. Our results are in line with the findings of Chaudhary *et al.,* (1987) those observed significant differences for number of branches among different varieties. The relationship between plant height and number of branches showed a linear regression with each other (Figure 3). The number of branches per plant increased by 0.08 with each cm increase in plant height of brassica varieties.

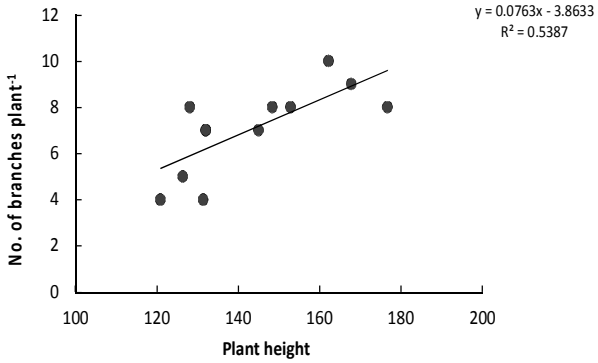

Figure 3: Relationship between plant height and number of branches plant^{-1} of hybrid and composite brassica varieties grown under rainfed condition.

These results contradicted with the investigation Olenjniczak & Adamaska, (1999) carried out on different brassica genotypes who reported that reduction in plant height causes an increase in vegetative growth and grain yield because of tolerance to lodging under unfavorable condition.

Fresh biomass traits (g): The recorded data of shoot fresh weight presented in Figure 4A showed significance difference among different varieties. The highest shoot fresh weight of 120.7 g was produced by hybrid brassica variety Hyola- 401 followed by Omega-3, while minimum amount of shoot fresh weight of 39.3 g was produced by Chakwal sarsoon. These results are quite in line with the results reported by Mobina *et al.,* (2007) who also reported significant difference among various brassica genotypes. In case of stem fresh weight, the recorded data presented in Figure 4B revealed that Hyola- 401 brassica hybrid produced maximum stem fresh weight of 52.9 g followed by Omega-1 whereas Chakwal sarsoon produced minimum stem fresh weight of 18.9 g.

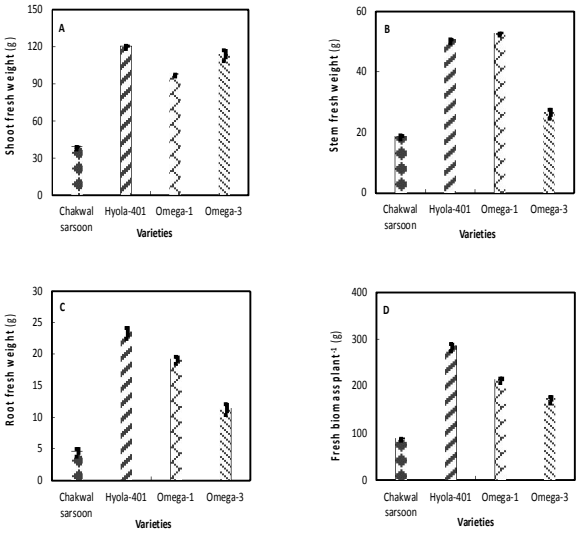

Figure 4: Comparative performance of shoot freshweight (A); stem fresh weight (B); root fresh weight(C) and fresh weight plant^{-1} (D) of hybrid andcomposite brassica varieties grown under rainfedcondition during winter 2010-11. Error bar representthe standard.

Same trend was followed by roots fresh weight in which presented in Figure 4C, Hyola- 401 hybrid overall produced higher root fresh weight (23.6 g) whereas minimum root fresh weight of 4.7 g was recorded by Chakwal sarsoon and thus less able to extant water from lower layers of soils and results less productivity than hybrid varieties.

Fresh weight plant^{-1} data presented in (Figure 4D) showed significant difference among brassica hybrids in comparison to Chakwal sarsoon. The maximum fresh weight plant^{-1} of 285.8 g was recorded by brassica Hyola-401 hybrid and minimum fresh weight plant^{-1} of 89.5 g by Chakwal sarsoon. Plant fresh weight of Omega-1 and Omega-3 were statistically at par with each-others. Gul and Rafique (2007) have also reported variation in fresh weight plant^{-1} in different genotypes of brassica crop.

Dry biomass traits (g): The data recorded presented in Figure 5A showed that in different brassica varieties, highest shoot dry weight of 56.0 g was obtained by brassica hybrid Hyola-401 and was statistically at par with Omega-3. Minimum shoot dry weight of 13.3 g was produced by Chakwal sarsoon. Significant variation has been reported by Mobina *et al,* (2007) in a study conducted with different brassica genotypes.

In case of stem dry weight, the recorded data also showed that brassica hybrid Hyola-401 hybrid produced maximum stem dry weight of 17.4 g, whereas Chakwal sarsoon produced minimum stem dry weight of 5.4 g.

The data indicating the root dry weight presented in Figure 5C showed significant difference among the brassica varieties. The results showed that maximum root dry weight of 8.2 g was produced by brassica Hyola-401 hybrid which was statistically at par with Omega-1 whereas minimum root dry weight of 1.9 g was recorded by Chakwal sarsoon. These results are in agreement with the findings of Aziz *et al*, (2006) who found that there was significant effect of cultivars on root dry weights of brassica cultivars. Similarly, Mondal and Paul (1995) who reported that Sambel cultivar had more root weight as compared to Daulat under soil moisture condition but in the present experiment, the Hyola hybrid had more root weight in comparison to rest of brassica varieties under study clearly indicating adoptability in dry land situation where rainfall in the growth season is 194 mm .

Data regarding dry weight plant^{-1} of different brassica varieties is presented in Figure 5D showed statistically significance difference from each other.

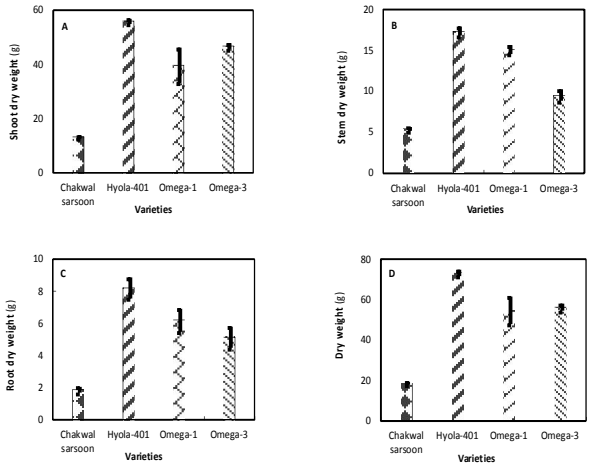

Figure 5: Comparative performance of shoot dry weight (A); stem dry weight (B); root dry weight (C) and dry weight plant^{-1} (D) of hybrid and composite brassica varieties grown under rainfed condition during winter 2010-11. Error bar represent the standard.

The maximum dry weight plant^{-1} (73.4 g) was recorded by brassica Hyola-401 hybrid while lowest dry weight plant^{-1} (18.7) was recorded by Chakwal sarsoon which apparently the result of poor root proliferation of composite variety and thus resultantly produced less shoot, stem and root weight and finally low plant dry weight when compared to hybrid varieties.

Forage yield (t ha^{-1})**:** Forage yield is one of the most important and ultimate objective of any fodder crop. Data regarding forage yield from different brassica varieties recorded during winter 2010-11 is presented

in the Figure 6A showed statistically significant difference among brassica varieties. Maximum forage yield of 70 t ha^{-1} was produced by hybrid brassica Hyola-401 variety, while the minimum forage yield of 17 t ha^{-1} was produced by variety Chakwal sarsoon. Brassica hybrid variety Hyola-401 produced three hundred times more forage yield in comparison to composite brassica variety Chakwal sarsoon. Our experiment results are in agreement with the findings of Sana *et al.,* (2003) who reported that Con-II hybrid variety produced the maximum biological yield as compared to other varieties and contradict with the findings of Jat *et al.,* (1987) and Cheema *et al.,* (2001) who revealed non-significant differences in biological yield among different brassica species which could be result of similar potential of hybrid and composite varieties but in the present experiment, the brassica hybrid Hyola-401 variety has produced more forage yield in comparison to others brassica hybrid as well as composite varieties grown under rainfed condition. The higher yield of brassica hybrid Hyola-401 was the result of higher plant height and number of branches plant $^{-1}$ which finally contributed to produce higher biomass compared to other brassica varieties.

Seed yield (kg ha^{-1}): Seed yield of a crop is the expression of combined effects of various yield parameters. Data pertaining to seed yield is presented in Figure 6B. Brassica varieties differed significantly for seed yield. The maximum seed yield of 3028.3 kg ha^{-1} was produced by Hyola-401 hybrid variety, which differed statistically from all other brassica hybrid as well as composite varieties. The minimum seed yield of 1159 kg ha^{-1} was produced by Chakwal sarsoon. Brassica hybrid Hyola-401 variety produced 161 % more seed yield as compared with Chakwal sarsoon.

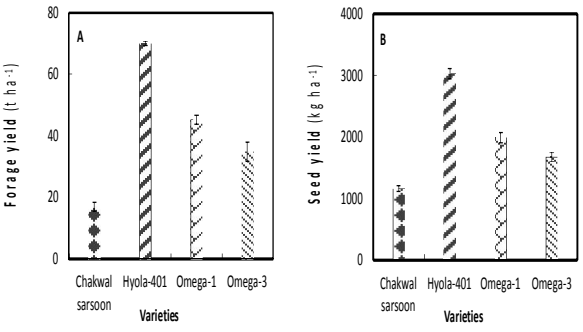

Figure 6: Comparative performance of forage yield(A) and seed yield (B) of hybrid and compositebrassica varieties grown under rainfed conditionduring winter 2010-11. Error bar represent the standard.

Our experiment results are in agreement with the findings of Cheema *et al.,* (2001) and Sana *et al.,* (2003) who reported that Oscar and Con-II varieties, respectively produced the maximum seed yield as compared to other varieties but in the present experiment, the brassica hybrid hyola-401 variety has produced more seed yield in comparison to others brassica hybrid as well as composite varieties grown under rainfed condition. The results were also supported by Reddy and Reddy (1998); El-Nakhlawy and Ahmed (2009) who reported that significant difference in seed yield among different brassica varieties.

The results of present study showed that forage yield of hybrid as well as composite brassica varieties exhibited positive and significant correlation with growth and yield components like plant height, number of branches plant^{-1}, stem dry weight, shoot dry weight, root dry weight, dry biomass plant^{-1} and seed yield (Table 1). The coefficient value for forage as well as grain yield with their components showed strong correlation of all brassica variables.

Table 1: Correlation coefficients of different growthand yield components of hybrid vs compositebrassica varieties grown under rainfed conditionsduring winter 2010-11.

Traits	FY	PH	NB	SDW	SHDW	RDW	DB
PH	0.93**						
NB	0.85**	0.73*					
SDW	0.94**	0.92**	0.84**				
SHDW	0.82*	0.71*	0.91**	0.80**			
RDW	0.91**	0.88**	0.84**	0.94**	0.91**		
DB	0.88**	0.78*	0.93**	0.88**	0.99**	0.95**	
SY	0.99**	0.94**	0.81*	0.90**	0.78*	0.88**	0.84**

FY: forage yield (t ha^{-1}); **PH:** plant height (cm); **NB:** number of branches; **SDW:** stem dry weight (g); **SHDW:** shoot dry weight (g); **RDW:** root dry weight (g); D**B:** dry biomass (g); **SY:** seed yield (kg ha^{-1}).
*Significant at 5% level, ** Significant at 1% level

4. Conclusion

It is concluded from this study that Hyola-401 brassica hybrid produced higher forage tonnage as well as grain yield compared with other tested hybrid and composites varieties under rainfed condition of Pothwar. The results clearly indicate the adoptability of Hyola-401 brassica hybrid than other varieties in comparison and thus can be recommended to the farming community to feed their livestock during the winter fodder scarcity period. However, farmers need due care while deciding to grow brassica crop as it complete with wheat area wise on which the sustenance of rainfed rural community is associated.

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