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EFFECT OF TILLAGE METHODS AND SOWING DATES ON YIELD, QUALITY AND ECONOMICS OF NEW BASMATI RICE (*ORYZA SATIVA* L.) VARIETIES UNDER DIRECT SEEDING IN SUB-TROPICAL CONDITION

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ABSTRACT

Resource conserving and eco-friendly interventions through improved crop establishment are the need of time to produce more with less resource. In this context, field experiment was conducted at Research Farm of Agrometeorology Section, Division of Agronomy, SKUAST-J, Chatha, Jammu, to investigate the effect of tillage methods *viz.*, zero (T_1) and conventional tillage (T_2) and sowing dates *i.e.* 10^{th} June (D_1) and 25^{th} June (D_2) on yield, quality and economics of basmati rice varieties *viz,* Basmati-370 (V_1) and new basmati rice varieties *i.e.* Jammu Basmati-118 (V_2), Jammu Basmati-138 (V_3) and Jammu Basmati-123 (V_4) with three replications in randomized block design during *Kharif* 2020. Basmati rice varieties grown under conventional tillage exhibited significantly higher grain yield (23.7 q/ha) and head rice recovery at 59.4%, as compared to zero tillage. The crop sown on 10^{th} June outperformed late-sown crops in yield and head rice recovery. Jammu Basmati-123 showed the highest grain yield, followed by Jammu Basmati-118, Basmati-370 and Jammu Basmati-138. The highest benefit-cost ratio was observed in conventional tillage (2.6) and crops sown on 10^{th} June (2.6). Under sub-tropical condition of Jammu region, the sowing of Jammu Basmati-123 had the highest benefit-cost ratio (2.7), followed by Jammu Basmati-118 (2.6), Jammu Basmati-370 (2.1), and Jammu Basmati-138 (1.9) due to the grain yield.

Key words : Basmati rice, Benefit-cost ratio, Conventional tillage, Head rice recovery, Zero tillage.

Introduction

Rice (*Oryza sativa* L.) is an important cereal crop in the world. It is staple food for more than 3 billion population and the demand is expected to increase day by day as the growth of population is increasing (Sharma and Khanna, 2019). Nearly, 90% of the total rice of world is produced and consumed in Asia (Elert, 2014). It is a dominating crop grown under North-Western India's fertile and alluvial soils, particularly in the Indo-Gangetic Plains (Banjara *et al*., 2022). Recently, rice production growth is about 0.36%, which is significantly lower than the population growth rate of 1.63%. A varietal group of rice has identified itself as specialty rice due to natural and human selection and has found widespread acceptance all over the world, which is called as "Basmati rice".

Basmati rice is also found to possess medium glycemic index between 56 and 69 (Atkinson *et al*., 2021). Cakmak and Kutman (2018) reported that basmati rice is a rich source of micronutrients especially in iron and zinc. In India, Basmati rice production was estimated about 8.2 million tons produced from an area nearby 1.8 million hectares during the year 2018-19 as compared to 9.0 million tons on an area of 1.9 million hectares in the previous year 2017-2018 due to weak and late onset of seasonal *monsoon* (Anonymous, 2019). Under sub-tropical belt of Jammu and Kashmir UT, rice is a major crop under irrigated areas during *kharif* season. Among the rice, basmati rice occupies a premium place and is cultivated on an area of about 62.4 thousand hectares with a production of 135 metric tons in Jammu region of J&K, UT (Anonymous, 2018). Rice producers have switched from transplanting to direct seeding due to lack of manual labour, increased irrigated area, invasion of early maturing rice cultivars and availability of selective herbicides for weed control, growing transplanting expenses and deteriorating profitability of the transplanted rice production system (Aslam *et al*., 2008). Direct sowing of rice under unpuddled conditions seems to be the most reliable option for efficient irrigation water saving technology apart from its cost and labour effectiveness. Low labour wages and adequate availability of water favours transplanting of rice, whereas high labour wages and low water availability favour direct seeded rice (Pandey and Velasco, 2005). Tillage operation of the soil has also been affecting soil properties as well as crop yield and tillage accounts for up to 20 per cent of crop development factors (Khurshid *et al*., 2006). Appropriate tillage operations prevent soil erosion while also maintaining crop yields and ecosystem stability. The aim of tillage is to establish a soil condition that is conducive for plant development (Klute, 1982). Many crops grown around the world use zero tillage establishments, which have the potential to save time, energy, water and labour during rice establishment. As a result, there is a lot of concern and emphasis these days on shifting from intense tillage to conservation and no-tillage methods in order to control soil erosion (Iqbal *et al*., 2005). Sowing date is another major factor that determines the productivity of a crop to ensure that vegetative development occurs when the temperature is suitable and the PAR of solar radiation is being used to its full potential. Second, right sowing time for each variety ensures that the sensitive growth stage of crop occurs when there are minimum night temperatures and the most favourable for grain development and thirdly, sowing at the right time ensures that grain filling occurs when cooler autumn temperatures are more prevalent, resulting in optimum grain quality and optimum seed yield (Farrell *et al*., 2003). Sowing dates that are too early or too late from optimum sowing time results in lesser crop production (Tiwari *et al*., 2018). Rice sown after the normal dates might result in decreased yields due to increased disease and pest attack, lodging caused by tropical storms and possible heat or cold damage during the heading and grain filling period (Groth and Lee, 2003). Traditional tall basmati rice varieties account for a significant portion of India's aromatic rice exports, but their productivity is poor as compared to non-aromatic rice varieties (Gangaiah and Prasad, 1999). So, introduction of high yielding varieties is an important factor to be considered for getting increased basmati rice production. In order to find out the influence of tillage methods and sowing environments on yield, yield attributes and quality parameters of basmati varieties and to work out relative economics of these treatments, an investigation entitled "Effect of tillage methods and sowing dates on yield, quality and economics of Basmati rice (*Oryza sativa* L.) varieties under direct seeding in sub-tropical condition" was conducted.

Materials and Methods

A field experiment was conducted at Research Farm of Agrometeorology Section, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu (SKUAST-J), Chatha during *kharif* season, 2020, which geographically lies on $32^0 40'$ N latitude and $74^0 82'$ E longitude with a height of 293 m above mean sea level under the sub-tropical foothills of Shivalik in Jammu and Kashmir. The experimental soil was sandy clay loam in texture having pH 7.14, organic carbon 0.38%, available nitrogen, phosphorus and potassium 211.13, 14.15 and 134.64 kg/ha, respectively.

The experiments consisted of two tillage methods *i.e.* zero (T_1) and conventional tillage (T_2), two sowing dates *viz*., 10^{th} June (D_1) and 25^{th} June (D_2) with four basmati rice varieties namely Jammu Basmati-370 (V_1), Jammu Basmati-118 (V_2), Jammu Basmati-138 (V_3) and Jammu Basmati-123 (V_4), the total 16 treatment combinations with three replications and laid out in split-split plot design under irrigated conditions. Initially, tractor-drawn equipment's were used to prepare the field except the area under zero tillage. After pre sowing irrigation, the experiment area under conventional tillage was thorough ploughing was done to break the soil clods and in order to achieve better tilth. Direct seeding of different basmati varieties was done with *Kera* method on 10^{th} and 25^{th} June under conventional and zero tillage by insertion at 5 cm depth by opening furrows manually, keeping row-to-row distance of 20 cm with the help of liner and 5 cm plant to plant distance as per the DSR guidelines during *kharif* 2020. In order to maintain plant population under zero and conventional tillage the different varieties of basmati rice was sown with the seed rate @ 35 and 30 kg /ha, respectively. The crop was provided with 30 kg/ha nitrogen (N), 20 kg/ha phosphorus (P_2O_5) and 10 kg/ha potassium (K_2O).

Fertilizer management : The crop was supplemented as per recommended dose of fertilizer in the package and practices of SKUAST-Jammu as nitrogen (N), phosphorus (P_2O_5) and potassium (K_2O) @ rate of 30, 20 and 10 kg/ha in the form of neem coated Urea, DAP and Murate of potash, respectively. Out of this, full dose of phosphorus, potassium and 1/3rd of nitrogen was applied at the time of sowing and rest of the nitrogen in two equal splits were top dressed at tillering and panicle initiation stage.

Weed management : For effective weed control, Pendimethalin @ 1 kg a.i./ha in 500-600 litres water was applied as pre-emergence herbicide on the same day after the direct sown rice crop. Thereafter, Bispyribac sodium @ 25 g a.i./ha in 750-1000 litre of water as post-emergence used at 30 DAS of each sowing environment in all the treatments under both the tillage methods.

Water management : In order to irrigate the experimental crop, surface flooding method was used to provide irrigation. Pre-sowing irrigation was applied to the experimental field four to five days prior to each sowing of crop under DSR. Then depending on the crop's need and rainfall status, various irrigations were applied to the field under both zero and conventional tillage.

Crude protein content (%)

The nitrogen content of rice grain was determined using Kjeldahl method, which involved digesting the seed sample with strong sulphuric acid in the presence of catalysts. By multiplying the relative nitrogen content in grain by a factor of 6.25, the protein content of basmati rice grain was determined (A.O.A.C, 1970).

Length / breadth ratio

Ten paddy samples were collected randomly from each plot after harvest. Then, the length and width of those samples were taken using vernier calliper. Average of all the ten paddy samples were taken and the mean length/breadth ratio (mm) of paddy grain was recorded.

Amylose content (%)

The amylose concentration of paddy grains was determined after they were cleaned, dried and dehusked. The iodine was absorbed by the helical coils of amylose, resulting in a blue-colored complex that was detected calorimetrically with a spectrophotometer at 590 nm (Juliano, 1971).

Head rice recovery (%)

Paddy sample of 25 g was taken and dehusked, the whole and broken grains were separated. The grains, which were either unbroken or which retained more than half of total size were separated. Head rice recovery was then computed as given by Gravois (1994) as follows:

$$\text{Head rice recovery (\%)} = \frac{\text{Weight of whole grains (g)}}{\text{Weight of paddy sample (g)}} \times 100$$

Gross returns (`/ha)

Gross returns for each treatment were determined by multiplying total grain and straw yields by current market prices of the item and then calculated on a per hectare basis. The sale rates of rice grain yield and straw yield of basmati rice used as per the local market in the calculation were ` 44.25/kg and ` 1.5/kg, respectively.

Net returns (`/ha)

Net returns (`/ha) of each treatment was computed by deducting its total cost of cultivation from the gross returns of the crop.

Net return (`/ha) = Gross return (`/ha) – Cost of cultivation (`/ha)

B: C ratio (`/ha)

B: C ratio was calculated by dividing net returns with the cost of cultivation for different treatment.

$$\text{B : C ratio} = \frac{\text{Net Returns (`/ha)}}{\text{Cost of cultivation (`/ha)}}$$

Statistical analysis : Statistical significance of the treatment effects on different parameters was determined for the least significant difference (LSD) at 5% level of significance using analysis of variance (ANOVA) for a split-split plot design (Cochran and Cox, 1957). On the basis of the null hypothesis, the results were tested for the treatments mean using the F-test of significance (Cochran and Cox, 1957). Standard errors with a threshold difference of 5% of significance were computed where necessary to distinguish treatment effects from chance effects (Panse and Sukhatme, 1967).

Results and Discussion

Yield : The seed yield of basmati crop was sown on 10th June under zero tillage method, the variety Jammu Basmati-123 gave the highest yield of 23.3 q/ha followed by Jammu Basmati-118 (22.6 q/ha), Basmati-370 (16.8 q/ha), Jammu Basmati-138 (16.5 q/ha). Whereas, the crop sown under conventional tillage method gave higher yield than zero tillage methods by basmati varieties were 25.3, 25.7, 21.6 and 26.0 q/ha by variety Basmati-370, Jammu Basmati-118, Jammu Basmati-138 and Jammu Basmati-123, respectively (Table 1). When the crop was direct seeded on 25th June under zero tillage method also similar types of pattern as in case of 10th June direct seeded crop but yielded less seed yield by the variety Jammu Basmati-123 gave the highest yield of 18.4 q/ha followed by Jammu Basmati-118 gave seed yield of 18.1 q/ha, Basmati-370 was 14.9 q/ha and lowest under Jammu Basmati-138 (13.7 q/ha). Whereas, when the crop was sown under conventional tillage method under direct seeded on 25th June yielded 22.3, 23.5, 21.7 and 23.8 q/ha by Basmati-370, Jammu Basmati-118, Jammu Basmati-138 and Jammu Basmati-123, respectively

Table 1 : Grain yield (q/ha) of basmati-370 and new basmati rice varieties under different sowing dates and tillage methods.

Varieties	10th June (D_1)			25th June (D_2)		
	Zero Tillage (T_1)	Conventional Tillage (T_2)	Mean	Zero Tillage (T_1)	Conventional Tillage (T_2)	Mean
Basmati-370 (V_1)	16.8	25.3	21.1	14.9 (11.3)	22.3 (7.9)	18.6 (11.8)
Jammu Basmati-118 (V_2)	22.6	25.7	24.2	18.1 (19.9)	23.5 (8.6)	20.8 (14.0)
Jammu Basmati-138 (V_3)	16.5	21.6	19.1	13.7 (16.9)	21.7 (-0.5)	17.7 (7.3)
Jammu Basmati-123 (V_4)	23.3	26.0	24.7	18.4 (21.0)	23.8 (8.5)	21.1(14.6)

The value in parentheses is percentage of less grain yield than 1st dates of sowing.

Table 2 : Effect of tillage methods and sowing environments on quality parameters of basmati rice varieties.

Treatments	Length (mm)	Breadth (mm)	Length/ Breadth ratio	Crude Protein content (%)	Amylose content (%)	Head rice recovery (%)
Tillage methods (T)						
T_1 : Zero	10.4	2.4	4.3	6.5	22.2	56.7
T_2 : Conventional	10.4	2.4	4.4	6.7	22.6	59.4
S.Em (±)	0.1	0.1	0.1	0.2	0.4	0.8
CD (5%)	NS	NS	NS	NS	NS	2.5
Sowing environments (D)						
D_1 : 10th June	10.2	2.4	4.4	6.6	22.4	58.8
D_2 : 25th June	9.8	2.3	4.3	6.6	22.4	57.2
S.Em (±)	0.1	0.0	0.1	0.18	0.4	0.5
CD (5%)	NS	NS	NS	NS	NS	1.5
Varieties (V)						
V1: Jammu Basmati-370	10.5	2.4	4.4	6.6	22.5	58.3
V2: Jammu Basmati-118	10.4	2.4	4.3	6.5	22.3	57.5
V3: Jammu Basmati-138	10.4	2.4	4.3	6.6	22.4	57.3
V4: Jammu Basmati-123	10.6	2.4	4.4	6.6	22.5	59.0
S.Em (±)	0.1	0.0	0.1	0.2	0.4	0.7
CD (5%)	NS	NS	NS	NS	NS	NS

All interactions: Non-significant.

(Table 1). Higher grain yield under conventional tillage might be ascribed due to the better soil conservancy and performance of yield attributing traits through optimum use of resources than zero tillage method. Similar findings were reported by Bhattacharya *et al*. (2006). Delaying of sowing for 15 days under zero tillage method showed variation in yield like Jammu Basmati-370 showed a reduction in yield by 11.3%, Jammu Basmati-118 showed a reduction in yield of 19.9%, Jammu Basmati-138 reduced the yield by 16.9%, whereas, Jammu Basmati-123 showed highest reduction in yield by 21%. The reduction in grain yield under delayed sowing might be attributed to a shorter vegetative development phase and low assimilates as a result of the delayed sowing and influenced by the temperature. These results are in conformity with Mukesh *et al*. (2013) and Acquaah *et al*. (2018). Delaying of sowing of direct seeded basmati rice crop for 15 days under conventional tillage method showed the reduction in yield by 7.9%under Jammu Basmati-370, 8.6% under Jammu Basmati-118 and 8.5% reduction in yield by Jammu Basmati-123, whereas the varieties Jammu Basmati-138 increased the yield by 0.5% under 25th June direct sown basmati rice crop in the irrigated condition of sub tropics of Jammu region, due to the short duration crop facing favourable environment at different growth stage as compared to 10th June sown

Table 3 : Effect of tillage methods and sowing environments on economics of basmati rice varieties.

Treatment	Cost of cultivation (`/ha)	Gross return (`/ha)	Net return (`/ha)	B:C Ratio
A) Tillage methods (T)				
T_1 : Zero	29096	86222	57126	2.0
T_2 : Conventional	30951	112197	81246	2.6
B) Sowing environments (D)				
D_1 : 10th June	29551	105530	75979	2.6
D_2 : 25th June	30496	92889	62393	2.1
C) Varieties (V)				
V_1 : Jammu Basmati-370	30024	93557	63543	2.1
V_2 : Jammu Basmati-118	30024	106580	76557	2.6
V_3 : Jammu Basmati-138	30024	86801	56778	2.0
V_4 : Jammu Basmati-123	30024	109890	79867	2.7

crop (Table 1). Because the seed yield of basmati rice crop positively highly significant with test weight (gm), numbers of effective tillers /m^2, number of grains/ panicles and significant with panicles length and straw yield (Table 4).

Quality parameters

The length and breadth of grains did not significantly differ with tillage methods, sowing dates and varieties; however, the early direct seeded basmati crop has found numerically higher length of grain compared to delay sowing and in case of varieties Jammu Basmati 123 and recorded numerically higher grain length followed by Basmati 370 than Jammu Basmati 138 and 118. Conventional tillage generally resulted in numerically longer and broader grains compared to zero tillage. The ratio of length/breadth of basmati rice crop was not significantly influenced by tillage methods, but the conventional method gives slightly higher ratio than zero tillage and similar type of trend was found among sowing dates *i.e*, higher under 10th June than 25th June sown crop. The crude protein content was also not significantly affected by tillage methods, sowing dates and basmati varieties. However, conventional tillage exhibited numerically higher crude protein content compared to zero tillage, while the sowing dates does not impact on crude protein. The crude protein content among the varieties were slightly lower in Jammu Basmati 118 compared to other three varieties. Amylose content was not significantly influenced by tillage methods, sowing dates and varieties of basmati rice. Conventional tillage recorded numerically higher amylose content than the zero tillage, whereas, the direct seeded basmati rice on different dates were not affected the amylose content. Jammu Basmati-123 and Basmati 370 were found slightly higher amylose content than Jammu Basmati-138 and the lowest in Jammu Basmati-118.

Head rice recovery was significantly influenced by tillage methods and sowing environments whereas, numerical difference was found under varieties. Between the tillage methods, significantly higher head rice recovery (59.4%) was recorded under conventional tillage than zero tillage method (56.7%). This might be obtained due to soil characteristics amelioration, improved fertilizer efficiency which prolonged the function of the top three leaves and further enhanced the photosynthesis and transport capability at the grain filling stage. Similar findings were also reported by Cay (2018).

Significantly, higher value of head rice recovery (58.8%) was observed under 10th Junethan 25th June (57.2%) sown crop. This might be due to adequate amount of photosynthetic production and translocation, which led to better grain quality under prolonged vegetative growth. This type of result was also reported by Mukesh *et al*. (2013) and Acquaah *et al*. (2018). Among different varieties, the head rice recovery was numerically higher in Jammu Basmati-123 (59.0%) than the Jammu Basmati-370 (58.3%), Jammu Basmati-118 (57.5%) and Jammu Basmati-138 (57.3%).

Economics

The gross returns, net returns and B:C ratio was calculated and the results are depicted in Table 3. Between tillage methods, crop sown under conventional tillage method has got the maximum net returns of 81246/ha with higher B: C ratio (2.6) as compared to zero tillage treatment. The lower yield was obtained in zero tillage as compared to the conventional tillage due to high weed

Table 4 : Correlation between yield, yield attributes and quality parameters of Basmati Rice crop

	Grain yield (q/ha)	Straw yield (q/ha)	Panicle length (cm)	Biological yield (q/ha)	No. of grains /panicle	No. of effective tillers/m^2	Test weight (gm)	Crude protein content	L/B Ratio	Head Rice Recovery
Grain yield (q/ha	1.000	0.643*	0.710*	0.808**	0.905**	0.821**	0.874**	0.674*	0.500	0.836**
Straw yield (q/ha)		1.000	0.853**	0.971**	0.792**	0.787*	0.836**	0.224	0.590	0.572
Panicle length (cm)			1.000	0.879**	0.770*	0.880**	0.835**	0.162	0.404	0.476
Biological yield (q/ha				1.000	0.892**	0.863**	0.917**	0.383	0.611	0.701*
Nos of grains/ panicle					1.000	0.851**	0.896**	0.591	0.664*	0.842**
Nos of effective tillers/m^2						1.000	0.866**	0.308	0.566	0.645
Test weight (gm)							1.000	0.476	0.659*	0.790*
Crude protein content								1.000	0.482	0.865**
L/B ratio									1.000	0.749

* Significant at 5% ** Significant at 1%.

manifestation (Singh *et al*., 2010). Therefore, the major challenge for farmers in direct seeded rice is effective weed management. Failure in weed control would result to very low yield (Moody and Mukhopadhyay, 1982; Moody, 1983). Though more fuel consumption was required under conventional tillage over zero tillage method but increased yield gave higher B: C. Similar results were obtained by Islam *et al*. (2014). The present study revealed that the 10^{th} June sown basmati rice crop gave maximum net returns (` 75979/ha) and B:C ratio (2.6) as compared to delayed sown basmati rice crop which generated net return (` 62393/ha) and B:C ratio of (2.1). The use of a suitable variety and timely sowing of basmati rice crop resulted in an adequate yield and net return with no additional costs. Late sowing had a negative impact on yield and decreases the net returns of the basmati rice crop. These results were also found by Akbar *et al*. (2010). From the above results it was affirmed that the 10^{th} June direct seeded basmati rice crop produced higher grain yield along with net returns and more benefit-cost ratio than the 25^{th} June. Highest benefit cost ratio (2.6) was accrued by Jammu Basmati-123 (2.7), followed by Jammu Basmati-118 (2.6), Jammu Basmati-370 (2.1) and Jammu Basmati-138 (2.0). This might have been attributed to higher yield of Jammu Basmati-123 as compared to other three basmati rice varieties under irrigated sub-tropical condition.

Correlation study

Correlation studies conclude that, panicle length, biological yield, number of grains per panicle number of effective tillers/m^2 and test weight (1000-grain weight) showed positive and significant association with grain yield and also among them indicating simultaneous selection for these characters would result in improvement of yield of basmati rice in sub-tropical region (Table 4). Similar results were also noticed by Nayak *et al*. (2001) and Madhavilatha (2002).

The results showed that grain yield had a highly significant positive correlation with head rice recovery and a significant positive correlation with crude protein content of basmati rice. The number of grains per panicle and test weight (1000-grain weight) showed positive and significant association with L/B ratio, whereas number of grains per panicle and crude protein content had positively significant correlation. The head rice recovery was also significantly correlated with biological yield and number of effective tillers/m^2 (Table 4).

The relationship between grain yield and quality

The grain yield of basmati crop were found to be positively significantly related with different yield

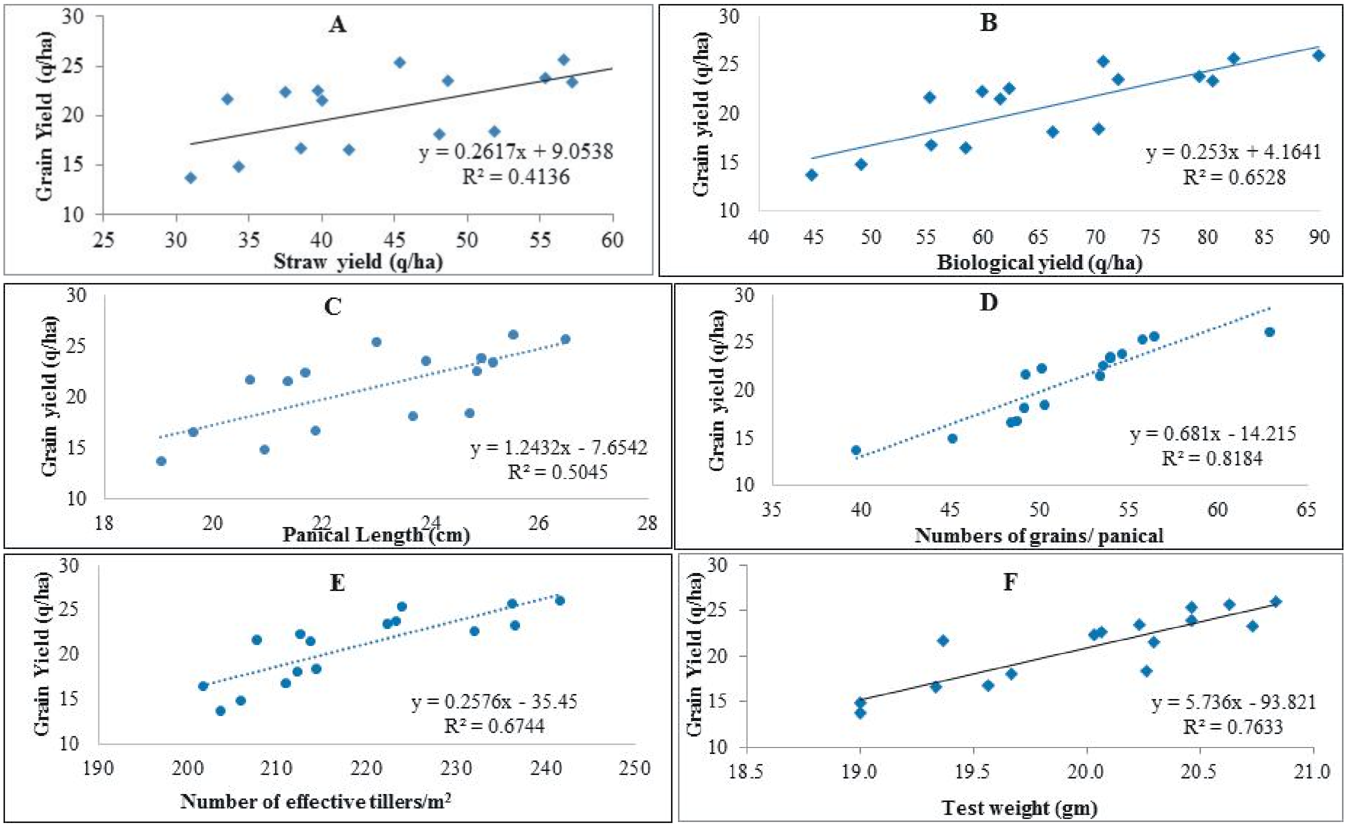

Fig. 1 : Relationship between grain yields and yield attributes of basmati rice crop under sub-tropical region.

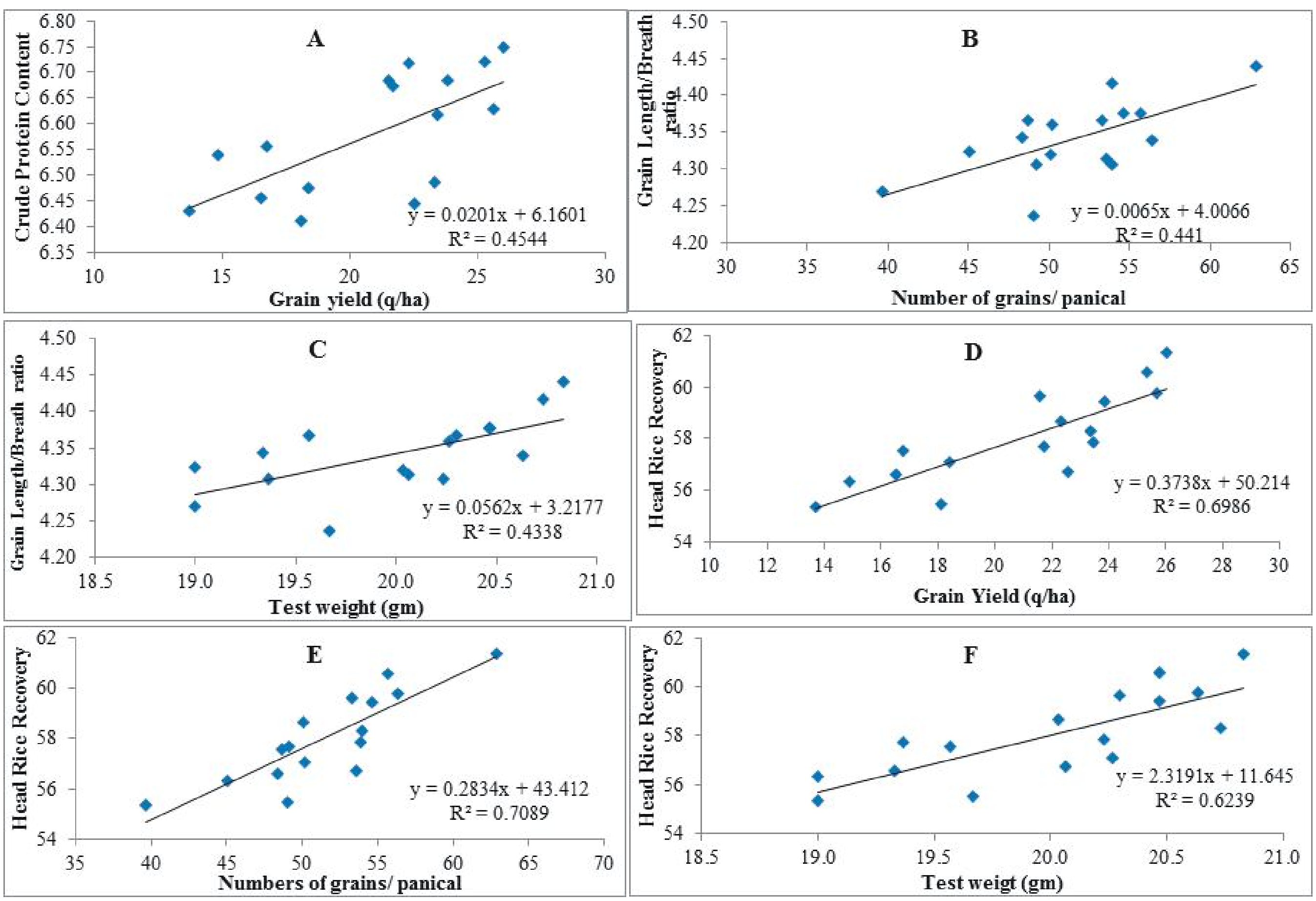

Fig. 2 : Relationship between quality parameters and yield attributes of basmati rice crop under sub-tropical region.

attributes (straw yield, biological yield, panicle length, number of grains per panicles, number of effective tillers and test weight) in sub-tropical condition (Fig. 1). The grain yield of basmati rice crop showed linear positive significance with straw and biological yield with rate of 0.2617 and 0.253 q/ha with accuracy of 41 and 65 per cent, respectively (Fig. 1 A and B). The increase in panicle length at rate of 1.243 cm had increased the grain yield of basmati rice by one quintal per hectare with a regression coefficient of 0.50, but increase of number of grains/panicle at rate of 0.681 significantly increased the grain yield (q/ha) with the accuracy of 82 per cent. The increase in number of effective tillers per m^2 and test weight at the rate of 0.2576 tillers/m^2 and 5.736 gm/ 1000 seeds significantly enhanced the per quintal grain yield of rice crop with accuracy of 67 and 76 per cent, respectively (Fig. 1 E and F).

The quality of basmati rice were directly dependent upon the grain yield and yield attributes. The crude protein content was found to be positively significant with grain yield at the rate of 0.0201q/ha increase in the one per cent of the crude protein content with 45 per cent accuracy (Fig. 2A). The basmati rice grain length and breadth ratio is directly associated with numbers of grains per panicle and test weight, while the head rice recovery rate was positively significant with respect to grain yield, numbers of grains per panicle and test weight (Fig. 2).

Conclusion

The current study concluded that the new released basmati rice variety, Jammu Basmati-123 direct seeded on 10th June under conventional tillage method accrued higher benefit cost ratio with superior quality parameters (crude protein content, amylose content and head rice recovery (%)) or similar with respect to Basmati 370 under subtropical condition of Jammu region. The grain yield and quality of basmati rice crop is directly associated with the yield attributes of the crop.

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